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Success factors of ERP system selection process

Czynniki sukcesu w procesie wyboru systemu ERP

Doctoral dissertation

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Abstract

Implementation projects for Enterprise Recourse Planning (ERP) information systems, which have become common in organizations in recent years, tend to pose a risk to the financial stability of organizations worldwide. These types of projects are distinguished by their high levels of complexity and have many potential failure points. They are often characterized by heavy budget and schedule overruns. Implementation projects can become a burden on organizations and fail before the system becomes operational. Research has shown that one of the critical factors in the success or failure of implementation projects is the selection process of the intended system. This study aims to identify the main elements in the managerial decision making process for ERP system selection which are important for successful selection results. Based on existing research and practice on success factors for the ERP selection process, the question arises: how are organizational environment and characteristics, together with decision making methodologies, associated with a successful selection process?

Based on the performed literature review of the decision making methodologies and ratings for selection criteria applied in the selection process, a gap in the knowledge was identified. It states the absence of a widely accepted selection method and agreed list of rated selection criteria. With the intention of reducing the gap and answering the research questions, an online worldwide survey, distributed to professionals, was conducted. The respondents were asked to rate selection criteria and share their experiences concerning the selection process they participated in, focusing on the use of decision making methodologies, external consultants' roles, the organizational environment and characteristics.

Analysis of the survey results showed the significance of some aspects of the organizational environment and characteristics for the selection process's success. On the other hand, no significance was identified in the use of decision making methodologies and a successful selection result. The results show no evidence of the beneficial contribution of the decision making methodologies, if used, in successful selection when compared with selections made without the use of decision making methodologies. Additionally, the

findings demonstrated the importance of the participation of professional external consultants in the selection process to its successful result. The results also indicate that some organizational characteristics and environments are important to the success of the selection process.

On the basis of these results, it is suggested that organizations use decision making methodologies which rely on selection criteria rated according to organizational characteristics, and are identified as important in a successful selection process. Further research is needed to clear up the uncertainty regarding the contribution of decision making methodologies to successful selection and also to identify additional connections between organizational characteristics and successful selection processes.

Introduction

This part of the thesis outlines general background information and contextualizes the research, including the aims of the study, problem formulation, research objectives, questions and hypotheses. The general structure of the thesis and an overview of the chapters are also presented.

Background

Over the past three decades, Enterprise Resource Planning (ERP) information systems have become important managerial instruments for decision making in a variety of management processes for different organizations worldwide. Its main feature is its ability to integrate between organizational processes, crossing fields of activity. Due to its complex structure, the ERP system implementation process involves high costs and risks of failure (Aloini, Dulmin & Mininno, 2007; Aloini, Dulmin & Mininno, 2012). The percentage of failures in implementation projects for ERP systems in the literature reviewed shows that between 24% and 70% of projects failed to be implemented and between 44% and 79% of the implemented projects experienced budget and schedule overruns (Standish group, 2009; Panorama consulting reports 2009-2018). These tendencies are supported by other studies (Davenport, 1998; Langenwalter, 2000; Ptak & Schragenheim, 2003; Loonam & McDonagh, 2005; Ahmad & Cuenca, 2013; Hughes, Rana, & Simintiras, 2017).

The current study reviewed the relevant literature regarding ERP system life cycle phases and the success and failure factors of the implementation process in order to reveal the causes of these high failure percentages. One of the factors that was identified as strongly related to the failure of ERP implementation projects was the ineffective or inappropriate selection of ERP systems (Bakås, Romsdal, & Alfnes, 2007; Aloini, Dulmin & Mininno, 2012). The selection process is a preliminary phase in every information system life cycle, where a poor selection which is not suited to organizational capabilities or needs can have a destructive effect on all the upcoming phases.

The selection process for an ERP system is managed according to various styles and methods. There is no agreed or standard method acknowledged either in the literature or in practice. However, there are multiple commonly used decision making methodologies which

are intended to support the manager in accepting the best decision for the organization. Among these methodologies, the Multi Criteria Decision Making (MCDM) method stands out. MCDM methods are mathematically based methods which have different levels of complexity and are applied in order to support selection between different alternatives according to the weightings and rankings given to multiple criteria. In the examined literature, from the time perspective there was no evidence of an accepted or united MCDM method or of a closed list of criteria concerning the ERP system selection process. The described cutting edge in this field of study, which maintains uncertainty and inconsistency in handling a key element of the decision making process for ERP system selection, which may possibly prevent improvement in the success rates of ERP system implementation projects, was the main trigger for conducting the current research.

Problem statement

Numerous studies conducted in the field have suggested and also tested different approaches to the decision making process in order to improve the chances of a successful selection of an ERP system (Cebeci, 2005; Lall & Teyarachakul, 2006; Ayağ & Özdemir, 2007; Asemi & Jazi, 2010; Şen & Baraçlı, 2010;Yang & Zhao, 2010; Içtenbas, Rouyendegh, & Erkan, 2012; Kilic, Zaim, & Delen, 2015 *inter alia*). However, these approaches, which derive from traditional types of decision-making theories such as normative, descriptive and prescriptive, did not produce desirable results and the success rates have not shown significant improvement over the years. This substantial literature gap between the amount of research done and improvement rates for successful ERP system selection processes requires a thorough and wide-ranging examination of the reasons for success and failure in the system selection process.

As a result of the literature review, the current study problem is formulated as the absence of a predefined pattern for the ERP system selection process, considering the importance of different factors to the decision making process in general and criteria rating specifically, including: consultants, application of decision making methodology, industry specificity, organizational size, organizational environment, roles of the decision makers in the organization and demographic uniqueness.

Aims of the study

The present study focuses on a review of the current state of the art in the ERP system selection field, including a chronological historical review of ERP system evolution milestones and an analysis of the commonly known theories and used practices.

Concentrated on identifying the existing gap in the decision making process for ERP system selection, the target is to define a consistent pattern for each of the core elements of the process. The general goal of the research is to develop a framework that can be applied to a decision-making process for ERP system selection and that can also become fertile soil for future research. The suggested approach is intendded to be comprehensive and simple to use in a way that will allow managers who are not specialists in MCDM methods to perform an effective analysis of the alternatives and make the most suitable decision for their organization.

In particular, the purpose of the current research is to contribute to the knowledge in this field of study by suggesting a practical application of decision making methodology using information retrieved from a worldwide survey of professionals. This should allow non-experts to consciously compare alternatives and perform a relatively informed evaluation of the required ERP information system for their organization.

From a management science point of view, the gap in knowledge should be reduced by developing a widely accepted, closed list of criteria which is extracted from the literature review, grouped, categorized and finally rated with weightings retrieved from the survey. Additionally, the research intends to investigate the importance of MCDM methods to a successful selection process as well as the importance of organizational characteristics, environment and consulting services to the success of the selection process.

From a practical point of view, the research should reduce the gap in managers' accessibility to multi criteria decision making methods via the suggested application of criteria ratings to MCDM methodology. Additional value in management practice should be achieved by enabling organizations, vendors and consulting firms to obtain the required tools and knowledge of aspects related to the successful selection process covered in the current study, and by doing so, contributing to progress in this area.

Research objectives

The presented study consists of three main objectives derived from the problem statement.

The first objective is to estimate the differences in the characteristics of organizations, determining the selection criteria ratings and their importance to the success of an ERP system selection process.

The second objective of the present study is to evaluate the importance of decision making methodology and external consultants to the success of ERP system selection.

The third objective of the present study is to evaluate the importance of organizational environment in the use of decision making methodology.

Research questions

The following research questions are extracted from the research objectives in order to specifically define the gaps in knowledge to be reduced by answering them in this study.

1) What are the differences in the ratings of the selection criteria and their importance to successful ERP system selection between industry types?
2) How do the ratings of the selection criteria and their importance to successful ERP system selection differ according to the size of the organization?
3) What are the differences in the ratings of the selection criteria and their importance to successful ERP system selection according to the geographical location of the organization?
4) What are the differences between various types of organizations in the ratings of the selection criteria and their significance to successful ERP system selection?
5) What is the importance of the use of decision making methodology to successful selection?
6) What is the importance of the professionalism of external consultants' services for the successful selection of an ERP system?
7) What is the importance of the organizational environment in the use of decision making methodology?

Research hypotheses

The following research hypotheses have been created on the basis of the literature review and the research questions. These hypotheses are examined and validated as part of this research. Hypotheses H1-H4 relate to the first objective of the study with successful selection and selection criteria as the dependent variables and organizational characteristics, such as industry type, used as the independent variables.

H1. The importance of selection criteria to successful ERP system selection varies according to the type of industry.

H2. The larger the size of the organization, the greater the importance of deciding on some of the ERP system criteria for successful ERP system selection.

H3. The rating of selection criteria and their importance to successful ERP system selection differs by organizational location.

H4. The importance of selection criteria to successful ERP system selection varies according to the type of organization.

Hypotheses H5-H6 relate to the second objective of the study with successful selection as the dependent variable and use of decision making methodologies together with the use of external consultant services as the independent variables.

H5. When decision making methodology is being used, the indicators for successful selection of an ERP system are higher.

H6. With the professionalism of external consultants, the indicators for successful selection of an ERP system are higher.

Hypothesis H7 relates to the third objective of the study with the use of decision making methodology as the dependent variable and organizational environment as the independent variable.

H7. The frequency of use of decision making methodology increases when there are such tendencies in the organizational environment.

Thesis structure

The present thesis is structured as an introduction and five chapters. The introduction comprises a general background and context of the thesis subject, aims of the study, problem statement, research objectives, questions and hypotheses presented. The first chapter consists of a literature overview of ERP system history and theories including ERP system life cycles and success and failure factors for ERP implementation projects. The second chapter consists of a literature review of ERP system selection methods including comparative analysis of MCDM methods used for ERP system selection processes. The third chapter consists of the research methodology, including a description of the theoretical research model, research problem formulation, research objectives, questions and hypotheses definitions. It also includes the research design, measures and survey questions as well as a description of techniques used for data collection and the characteristics of participants. Chapter four deals with the evaluation of elements of the ERP system selection process and presents the results analysis. It includes the descriptive statistics review of the results, definition of variables and analysis of the objectives by hypotheses testing. The fifth chapter presents a discussion of the research results, limitations and a description of the implications. It also includes further research suggestions and conclusions.

1 ERP system historical overview and relevant theories in management science

1.1 Introduction

The ERP (Enterprise Resource Planning) system is an information system that was presented in the 1990s and became popular in the following decades. ERP is a comprehensive and diverse management tool that enables the organization to manage its business activity and to increase the efficiency of each one of the processes in particular and the whole constellation of processes in general. This is enabled by the integrated structure of the system, which is composed of different modules that are responsible for all areas of business activity. The influence of the ERP system on the organization does not end there, and frequently it also influences organizational and business structures and processes, their simplification, efficiency and the integration between them (Donovan, 2000; Remenyi, 2000).

Conversely, this very nature turns the process of implementing the ERP system into a dangerous and risky project for the organization. There are many possible factors contributing to failure, such as project size, complicated structure, high costs and tight schedule (Ahituv, Neumann, & Zviran, 2002). Under these conditions, the incompatibility between the selected system and the organization can be disastrous for the organization.

This chapter sets the goal of briefly describing and analysing the state of the art of the ERP selection and implementation field, and will also include a chronological historical review of ERP systems evolutionary milestones. It will briefly discuss the popular implementation strategies for ERP systems as well as budgetary dilemmas and difficulties. The importance of the selection process will also be demonstrated.

Similar to other information systems, ERP has life cycle models which try to organize the different phases of a system's life time. The prioritization and comparison of the different phases, suggested by different researchers, will be discussed later in this chapter. While moving through the ERP project phases, many factors have an influence on the success or failure of the project. Those factors that were identified, sorted and grouped by a variety of researchers in many alternative ways, under the title of critical factors of success or failure, will also be reviewed and compared in this chapter.

1.1.1 History and evolution of enterprise management information systems

1.1.1.1 Background

The history of corporate information systems development has several chronological stages. In order to standardize and optimally manage the production and inventory of goods, the American Production and Inventory Control Society (APICS) developed the principles for enterprise inventory management. These principles were the basis of the MRP (Material Requirements Planning - planning the needs of an enterprise for material resources) concept (Ptak, 1991).

In the early stages, in the 1970's, the information systems that were implemented met the MRP standard of enterprise management. The implementation of these systems using MRP methodology made it possible to combine production, planning and inventory management into a single business process. However, these systems did not take into account production capacity, load, labour resources and more. This drawback led to the development of the MRP II concept. In this case, the MRP abbreviation stands for Manufacturing Resources Planning. Subsequently, this concept had evolved by the end of the 20th century into ERP systems (Enterprise Resource Planning), which is based on the principle of creating a unified data base containing all business information accumulated by an organization in the course of business operations, including financial information, data related to production management, human resources management and any other relevant information. In addition, any piece of information that an organization has at its disposal becomes simultaneously available to all employees who have the appropriate authorization (Al-Mashari, Al-Mudimigh, & Zairi, 2003; Jacobs, 2007).

1.1.1.2 MRP concept overview

The MRP approach intended to minimize the costs associated with the inventory management process or other various stages of the production process. It is based on product specification (BOM[1]), which shows the dependence of the demand for raw materials, semi-finished products, by-products etc. on the finished product release plan, taking the time schedule into account. On the basis of the plan of production, product specifications and consideration of the features of the technological process, calculation of production needs for

[1] Bill of material

materials and specific time periods is carried out. This concept was used for the creation of MRP information systems (Orlicky, 1975).

1.1.1.3 MRPII concept overview

The MRPII approach is based on effective management of all resources of the enterprise: forecasting, planning and production control are carried out throughout the entire life cycle of products, ranging from the purchase of raw materials to the shipment of final products to the consumer. One of the missing features in the MRP concept is that it does not take into account production capacity, its loading, labor costs, etc. when calculation of the need for materials takes place. Therefore, in the 1980's, narrow, from an integration point of view, MRP systems were transformed into a manufacturing resource planning system, called MRPII. The objective was to ensure the planning of the enterprise in physical units, with financial indicators described in monetary terms, modeling the capabilities of the enterprise and answering the question "What will happen if?" (Plossl & Orlicky, 1994).

The main goals of MRPII as described by APICS, mentioned previously, are

- Reduced inventory.
- Accurately predicted delivery times.
- Accurate costing at every stage of the manufacturing process.
- Improved use of manufacturing facilities.
- Faster response to changing conditions.
- Control of every stage of production.

The APICS standard on MRPII class systems contains a description of categories of system functionalities such as sales and production planning, planning needs for materials, product specifications, warehouse management, capacity needs planning, resource allocation planning, financial management, performance evaluation and more (Rondeau & Litteral, 2001).

These categories enable the integration of planning functions, including the coordination of various management processes. The presented set of categories is not redundant and that is why it is mostly kept in module structure in the information systems of current generations.

1.1.1.4 ERP concept overview

The ERP enterprise management system emerged in the early 1990's, first introduced by the analytical company Gartner Group (Wylie, 1990). The ERP system is an integration of MRPII class systems and financial requirements planning. ERP eliminates the need to transfer data from one system to another and also ensures availability of information for any number of enterprise employees, the system users, who have the appropriate authorization and security permissions, simultaneously (Blackstone & Cox, 2005). The ERP system features all the management information system levels as described in the professional literature: TPS, MIS, EIS and DSS. The TPS (Transaction Process System) records the routine data activities that occur in the organization, such as entering data from the various departments on sales, shipments, inventory, financial transactions etc. The MIS (Management Information System) is designed to assist managers at the middle operational level in making ongoing operational decisions, thereby improving the organization's activity results. The EIS (Executive Information System) is intended for use by high level managers, and includes summarized data that provide an overall picture rather than a specific picture. However, there is always a drilldown option to the specific information, considering the fact that data for the EIS is generated from the TPS and the MIS systems, and also from a data warehouse. The DSS (Decision Support System) supports the decision-making processes of the organization. The system is designed to assist managers at the managerial, operational and strategic levels to make decisions that are not comprehensible or semi-structured. For example, non-standard decisions, being made under conditions of uncertainty; new decisions that the manager has no previous experience of dealing with; decisions that must be adopted quickly; or decisions made in a rapidly changing environment (Yoon, Guimaraes, & O'Neal, 1995).

An ERP system is a set of integrated applications that allow organizations to create an integrated information environment (IMS) for automating the planning, accounting, control and analysis of all core business operations of the enterprise (Kopia, Kompalla, & Ceausu, 2016).

1.1.1.5 ERP II concept overview

One of the expansions of the classic ERP system, proposed by the Gartner Group in 2000, the ERP II (Enterprise Resource & Relationship), is the result of the development of ERP

methodology and technology in the direction of closer interaction of the enterprise with its customers and suppliers. At the same time, the company's management information is not only used for internal purposes, but also serves to develop cooperative relations with other organizations. In a simplified form, ERP II is an advanced ERP system with which the SRM[2] and CRM[3] systems are integrated deeply and are accompanied by a corporate internet portal, the Intranet, through which company employees can obtain all the necessary information and interact with each other, as well as an Extranet portal which is an internal portal that gives access to partners and customers (Beheshti, 2006).

The concept of ERP II is aimed at automating external relations and creating a so-called "virtual enterprise", reflecting the interaction of production, suppliers, customers, partners and consumers, consisting of autonomously operating business functional areas or a temporary association of such areas working on one project, program, etc. The ERP II system also has the functionalities of financial management, accounting, online sales and shopping management, relations with creditors and debtors, banks, HR management, production process, inventory management, and also enables the management of customer relationships, supply chains and online trade (Møller, 2005).

1.1.2 Importance of ERP system selection

The choice of an ERP system has significant implications for the financial future of the organization, because of the high costs and the many risks bringing a high chance of failure (Aloini, Dulmin, & Mininno, 2007). A review of failure in the implementation of ERP systems, according to research performed by the Standish Group in 2009, indicates that 24% of implementation projects ended before 'going live' and 44% of those completed as having budget overruns or schedule deviations. Between the years 2009 and 2017, an average of 62% experienced project duration overruns (Figure 1).

[2] Supplier Relationship Management
[3] Customer Relationship Management

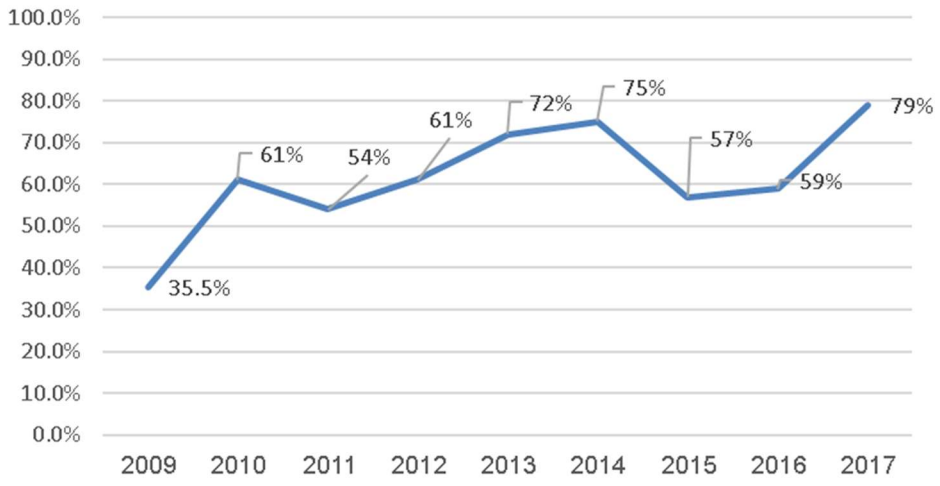

Figure 1. Duration overruns experienced by organizations

Source: Panorama consulting reports between the years 2009 and 2018.

Other research studies show the same tendency of 50%-70% of partial or complete failure (Davenport, 1998; Langenwalter, 2000). ERP implementation projects may fail in 40%-60% of cases, and if one judges the success of the project according to the ROI[4] of the ERP system, this can reach a rate of 60%-90% failure (Ptak & Schragenheim, 2003). The research studies further indicate that the failure of projects to implement ERP systems is related to the selection of ERP systems that are not effective or suitable (Bakås, et. al. 2007).

The percentage of implementation projects considered failures by the organizations themselves, according to a review conducted yearly by the Panorama Consulting Group, shows an 18% average between the years 2012 and 2017 with almost constant growth reaching the 28% mark in 2017 (Figure 2). A further 24% (on average during the same period) of the respondents were not able to ascertain whether their organization's project is defined as a success or a failure.

[4] ROI – Return on Investment

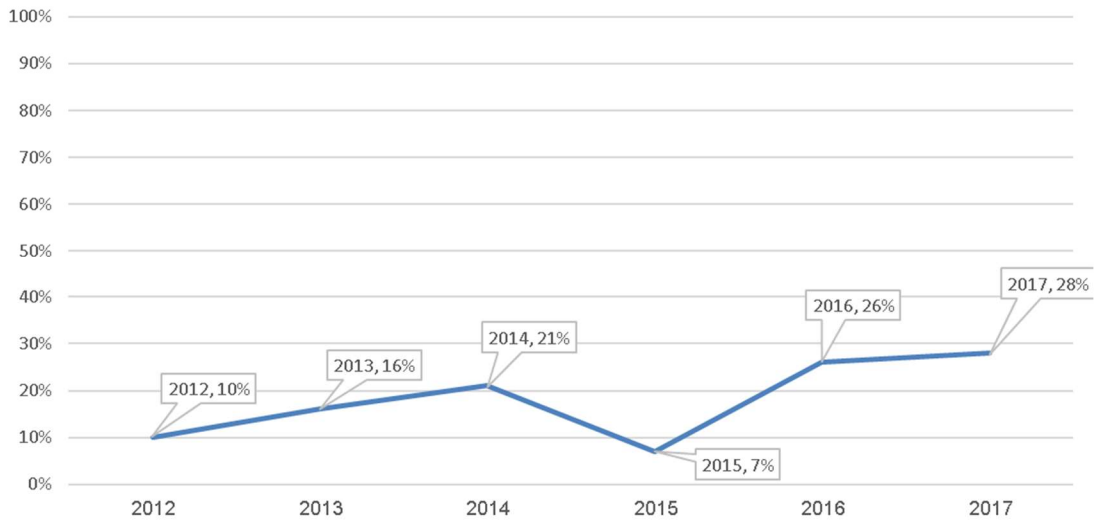

Figure 2. Percentage of projects considered as failures by organizations

Source: Panorama consulting reports between the years 2013 and 2018.

In their search for influential and measurable elements that determine the success or failure of the process of implementing ERP systems, the researchers identified the success factors approach as suitable. These factors appear during different stages of the project, and their level of influence may vary. Moreover, while some of them contribute to the success of a project, others may be destructive to it.

1.1.3 ERP system implementation budgeting and costs

As part of the decision-making process regarding ERP system selection and the implementation project, organizations formulate a preliminary budget estimate of the project to be implemented. This budget includes the cost of the program itself (software shell, user licenses etc.) and the services of the system integrator. The estimate will also include setting up and customization costs based on existing business processes, the cost of user training services (there is also a training center and support services for enterprises), the cost of purchasing or renting additional equipment (such as servers), as well as the possible costs of hiring high-cost third-party consultants. The costs involved with the participation of various functionaries from within the organization in the different project phases, instead of their original occupations and tasks, will also be taken into account. Possible deviations from the estimates will be part of the initial budget. Organizations that implement ERP systems, as well as external consultancy companies, consider actual costs which exceed the planned costs by 10–15 percent as normal, but in practice these discrepancies are often greater (Mabert, Soni, & Venkataramanan, 2003). An average 60% of the organizations which implemented ERP reported experiencing cost overruns on their projects between the years 2009 and 2017 (Figure 3).

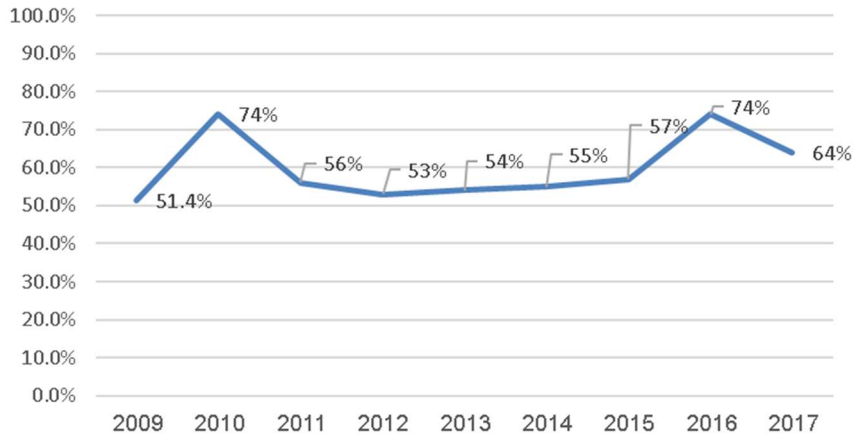

Figure 3. Cost overruns experienced by organizations

Source: Panorama consulting reports between the years 2009 and 2017.

Thus, companies running an ERP project are faced with necessary, but sometimes unexpected, additional costs. For many, this is the cost of staff training, which is often comparable to the cost of the system. However, users almost always have to master a new

set of processes, and not just another program interface, which increases the amount of costs. Another budgetary issue often occurs when integrating connections and interfaces between modules and other programs. In many organizations, software systems for procurement, production planning, financial reporting, etc. are already operating. If additional ERP system configuration is required to ensure compatibility with these programs, a sharp rise in the costs of integration, testing and software maintenance may be inevitable. Payment of consultants is also a major expense, which can be limited and minimized by defining responsibilities during the contract phase between the consultants, customers, vendors etc. (Kumar, Maheshwari, & Kumar, 2003).

1.1.4 Implementation strategies

The implementation stage, which is actually the encounter between planning and reality, constituted fertile ground for several popular methods of implementing ERP systems. These methods will be briefly explained in the following paragraphs with the purpose of bringing closer together the theoretical discussion and the practical applications often used by a wide range of organizations during their ERP project implementation phase (Holland & Light, 1999; Aladwani, 2001).

One of these strategies, named the Phased Rollout implementation strategy, adopts related business processes into the ERP system and dismisses legacy systems according to the element decided upon, such as business unit type or geographical location, business process or the module involved. This type of implementation has a comparably lower risk of failure because of its multi-stage strategy which offers some flexibility. On the other hand, during the long implementation process dictated by this strategy, several systems will be used simultaneously by the organization, which will be burdened by high costs, consistency and compliance issues between the different systems, and users' difficulties with the aspect of maintaining legacy systems skills and obtaining new ERP system proficiency (Scott & Vessey, 2000; Kraemmerand, Møller, & Boer, 2003). Some of the strategies are also being used in other types of information system implementation projects (Owens, 2008).

Another strategy called the "Big Bang" implies full, complete and immediate activation of the ERP system. This means there is a "go-live" stage when all the ERP system features and modules are activated, all the users become active and the legacy systems are turned off within a very short period of time (1-7 days approx.). There is no option to go back and

reactivate or use the legacy systems when employing this strategy. This is a significantly riskier option, which is often preferred by companies with a simple organizational structure and relatively uncomplicated business processes. This method requires an intensive testing phase, since it is necessary to carefully check how accurately all business processes have been implemented and are ready for the "go-live" stage. This strategy's length is shorter than the others and also less costly for the organization if successful. In the case of failure it can harm and adversely affect all the business processes of the organization at once (Karakanian, 2000).

Other types of implementation strategy are variations of Rollout, implementing one area of production or business process (in a department, branch, etc.), and then spreading to other areas. The implementation itself can be carried out as a phased rollout or as a "big bang". The risk in this case, as a rule, is insignificant. It is necessary to carefully analyse which of the specified strategies of ERP implementation is the most suitable for the specific organization (Madapusi & D'Souza, 2005).

Making an effort to minimize the risks involved with a "go-live" stage, some organizations apply the Parallel adoption strategy, which allows the legacy software to run simultaneously with the ERP system. This strategy reduces the risks of an implementation project, especially of a disaster scenario, and has a shorter implementation schedule than the Phased approach (Holland & Light, 1999). On the other hand, it is the alternative that consumes the largest budget, maintaining several information systems at the same time and processing duplicate data. Additionally, hybrid approach strategies are often used by organizations which provide an option to use the most suitable strategy for different organizational structures and needs, gaining flexibility. An example can be an implementation that uses a "big-bang" strategy for small units and phased rollout for globally spread units (Madkan, 2014). The popularity of application of these approaches is demonstrated in figure 4.

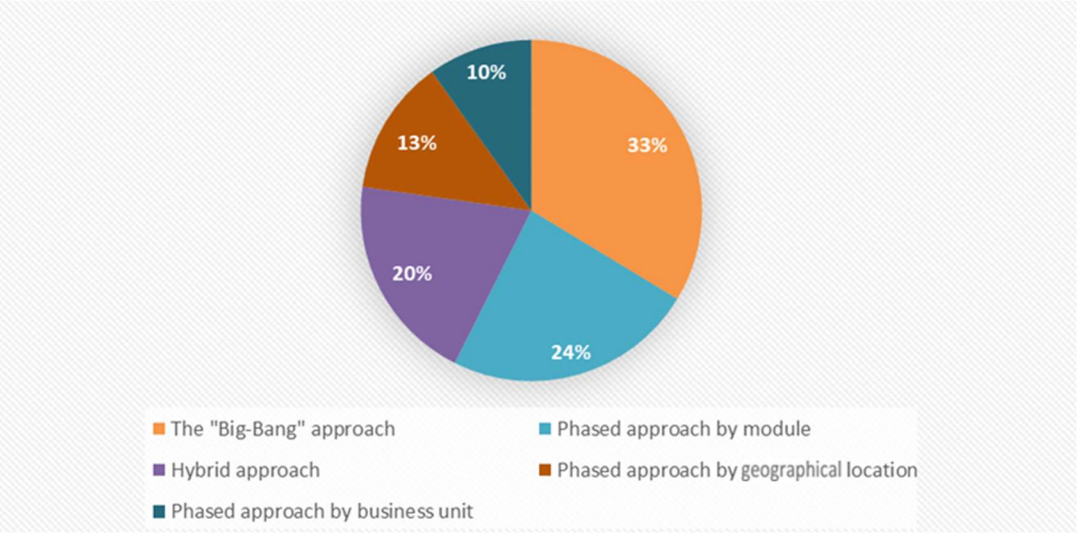

Figure 4. ERP implementation approaches distribution of use

Source: Panorama consulting report 2012.

1.1.5 Management science disciplines involved in the ERP system selection process

An ERP system is an integrated management system used by managers of all levels and relevant to many kinds of managerial decisions. In addition, the selection process of the organizational ERP system specifically and the implementation project in general are saturated with management decision-making points. Respectively, each process involves some of the management science disciplines. The current part of the review briefly introduces three disciplines from the perspective of the ERP selection process and the implementation project.

1.1.5.1 Management consulting

This field of management science attempts to describe the theoretical background of the professional support and advice given to organizations at the managerial level in the design, planning and fulfilment of its strategic needs by an external organization or consultants. The need for this kind of service often arises when the organization stands before significant changes in its processes which involve knowledge and experience in fields it has lack of expertise in or when it wishes to obtain an external point of view, gaining an additional 'new' approach (Kubr, 2002). ERP system selection and implementation processes are commonly assisted by consulting services due to the unique knowledge needed to plan these complex procedures and make decisions that will be beneficial for the organization (Wang, Jiang, & Klein, 2007). There are numerous consulting firms providing services in this area and some of them contribute to monitoring the tendencies in the ERP system field by publishing periodical research reports. These types of reports include analysis of the success and failure results of ERP system projects, attempting to reveal and quantify the factors of each. The relationship between the use of these external consulting services and the successful selection of the ERP system is covered in the present study.

1.1.5.2 Project management

Project management is a managerial science field concentrating on planning and controlling activities in projects. A project can be defined as a time and budget limited effort to achieve a desired goal. A purpose of a project can be the creation or modification of a service or a product as well as any other unique result. Organizations often conduct projects that can improve the efficiency or effectivity of their processes or achieve any other targets set. The project requires resources to achieve the goals for which it is being implemented. Project management, in its turn, can be defined as the set of activities designed to complete the project on schedule, meeting its budget and accomplishing its aims with a level of quality that can satisfy the customer (Koskela & Howell, 2002) . Project management is often carried out using methodologies developed to help managers meet project objectives. By nature, projects can have many risks and failure points and management methodologies are developed in order to minimize them as much as possible. These methodologies consist of systematic approaches for practical project management following predefined phases. Information systems development, selection or implementation processes are usually

referred to as projects that require unique and suitable project management methodologies. Over the years different approaches to information system project management have been suggested. Traditional types of project management were characterized by strict documentation, pre-set structured phases and milestones, allowing only minor flexibility for changes, if any. Traditional approaches of the life cycle type, such as waterfall and spiral models, gained in popularity from the 1970's and are still widely used. The main characteristic of these models is the assumption that a project can be fully structured and planned in detail from the beginning using strict formal documentation and following pre-defined phases according to their order. Projects of this type are driven by tasks and activities (Nerur, Mahapatra, & Mangalaraj, 2005).

The modern approaches are more dynamic and change-driven which allows flexibility during the project phases. Flexibility is accomplished by using an iteration process and incremental features. Such approaches, like Agile project management and Scrum methodology, as its extension, are part of the evolutionary-delivery group of models, which became fashionable from the late 1990's and offer a more flexible alternative (Cervone, 2011). The main characteristics of these models are working in small teams and improving results on-the-go by receiving live feedback and change requests. They demand less formal documentation and the phases can be repeated and their order can be changed during implementation if necessary. Projects of this type are driven by product features or the expected result of the featured process, requiring customer involvement through the different project phases (Fernandez & Fernandez, 2008).

The ERP system of implementation project management is, uniquely, a general information system management project. An ERP system type project has additional specific characteristics in its project management as a result of its complex structure, size and cross-organizational impact on processes, long schedule, high consumption of organizational resources and the multiple languages of project team members (which can be typical in global enterprise organizations). The selection of an ERP system is a preliminary stage of the implementation project, which can have a strong connection with the results of the project and be the cause of success or failure (Chen, Law, & Yang, 2009). Because of its crucial role, it is often handled as a standalone project with different team members, managers and other

decision-makers dedicated to it. The goal of this type of project is to select the most appropriate and suitable ERP system for the organization (Weston Jr, 2001).

1.1.5.3 Decision analysis

Managers deal with the decision making process as part of their role definition. Decision analysis is the management science discipline providing the methodologies that support decision making for complex problems that are made under conditions of uncertainty and thus carrying the potential risk of negative consequences for the organization. These methodologies involve data analysis and as an output can suggest recommendations for a decision that is to be made (French, 2014). Many different techniques were used over the years with the purpose of dealing with complex decision making. Some of them use probability for modelling and simulating uncertainty as well as applied statistics that consist of descriptive statistics and inferential statistics, stochastic game theory and others. A main division defining the type of decision analysis is the number of objects or criteria to be analysed. For one objective or criterion to be analysed, single-objective analysis methodologies are applied. Another case is where several objectives or criteria should be taken into account when a decision analysis is being carried out, necessitating the use of multi-objective or multi-criteria methodologies (Parnell, Bresnick, Tani, & Johnson, 2013). The information system selection process in general and the ERP system selection process in particular are addressed as a multi-criteria decision analysis process in the literature due to its high complexity and the high number of factors, criteria and objectives that are involved in the selection process (Figueira, Greco, & Ehrgott, 2005). A literature review of suggested methodologies relevant to the ERP system selection problem is covered in the next chapter.

1.2 ERP systems implementation life cycle

The process of the implementation of an ERP system is composed of a number of phases and sub-phases, about which there are differences of opinion in a wide range of research studies. For the past 30 years there have been a great number of attempts to propose a generic model, but as of now an accepted and agreed upon model of the phases and the life cycle has not yet been defined (Hasibuan & Dantes, 2012). One of the early models was

presented by Cooper and Zmud (1990) for the MRP[5] system, which was the predecessor of the ERP system and included six stages: (1) the stage of initiation, (2) the stage of adoption, (3) the stage of adaptation, (4) the stage of acceptance, (5) the stage of routinisation, and (6) the stage of infusion. Each one of these stages was divided into the process and product so as to describe the course of action and its outcome. The stage of initiation includes the review of the topics that influence the organization's efforts towards the implementation of the new IT system, such as technological innovations and organizational needs. The stage ends with the choice of a suitable system. The stage of adoption focuses on the inner-organizational discussion on the chosen solutions that ends with the decisions about the allocation of resources. The stage of adaptation includes the sub-stages of development, installation, maintenance, and training, and at its end the organization has a fully active and operational system. The stage of acceptance constitutes an indication of the users' commitment to using the system and ends with full system sufficiency. The stage of routinisation is dedicated to the encouragement of the use of a system that becomes a routine activity. The final stage of infusion has the aim of increasing the effectiveness of the use of the system while receiving the maximum contribution from the system to the organization. This life cycle model was evolved by Somers and others to an ERP life cycle model with similar phases (Somers, Nelson, & Ragowsky, 2000).

In the 1990s and early 2000s, there were a number of additional attempts to propose models of the life cycle in ERP systems, such as Bancroft, Seip, and Sprengel (1998); Gable, Scott, and Davenport (1998); Chang and Gable (2000); Markus and Tanis (2000); Ross (2000), Shanks, Parr, Hu, Corbitt, Thanasankit, and Seddon (2000); Sandoe (2001); Corbitt and Boykin (2001); Esteves and Pastor (2001).

In the following decade, the life cycle of the ERP system proposed by Stefanou became the basis for many research studies. It includes four phases (Fig.5): (1) The business vision regarding the initiation of ERP in the organization, (2) Selection of ERP software, vendor and implementation partner for implementation, through the examination and definition of the business needs, expectations, and limitations with the goal of finding the most suitable system. This phase includes the evaluation of the commitment to the change in the

[5] MRP System – Material Resource Planning System

organization and the software modules expected to be implemented during the process. (3) Estimation of the costs and benefits of the implementation project is expressed in this phase. (4) The analysis of ERP operation and maintenance occurs in this phase (Stefanou, 2001).

In contrast to earlier models, the Stefanou model assumes the evaluation of the advantages and the risks from the perspective of the organizational cost or benefit in every phase of the life cycle before the transition to the next stage and additional evaluation at its end. From the same perspective, the model is similar to other progressive models of management software development by the incremental approach, such as Scrum and Agile (Fernandez & Fernandez, 2008). The above models of life cycle published before Stefanou's model (Figure 5) were characterised by a general description of the project phases and as a result lacked critical elements. The prioritisation of the stages according to their influence on the success or failure of the implementation of the ERP system was not proposed in them.

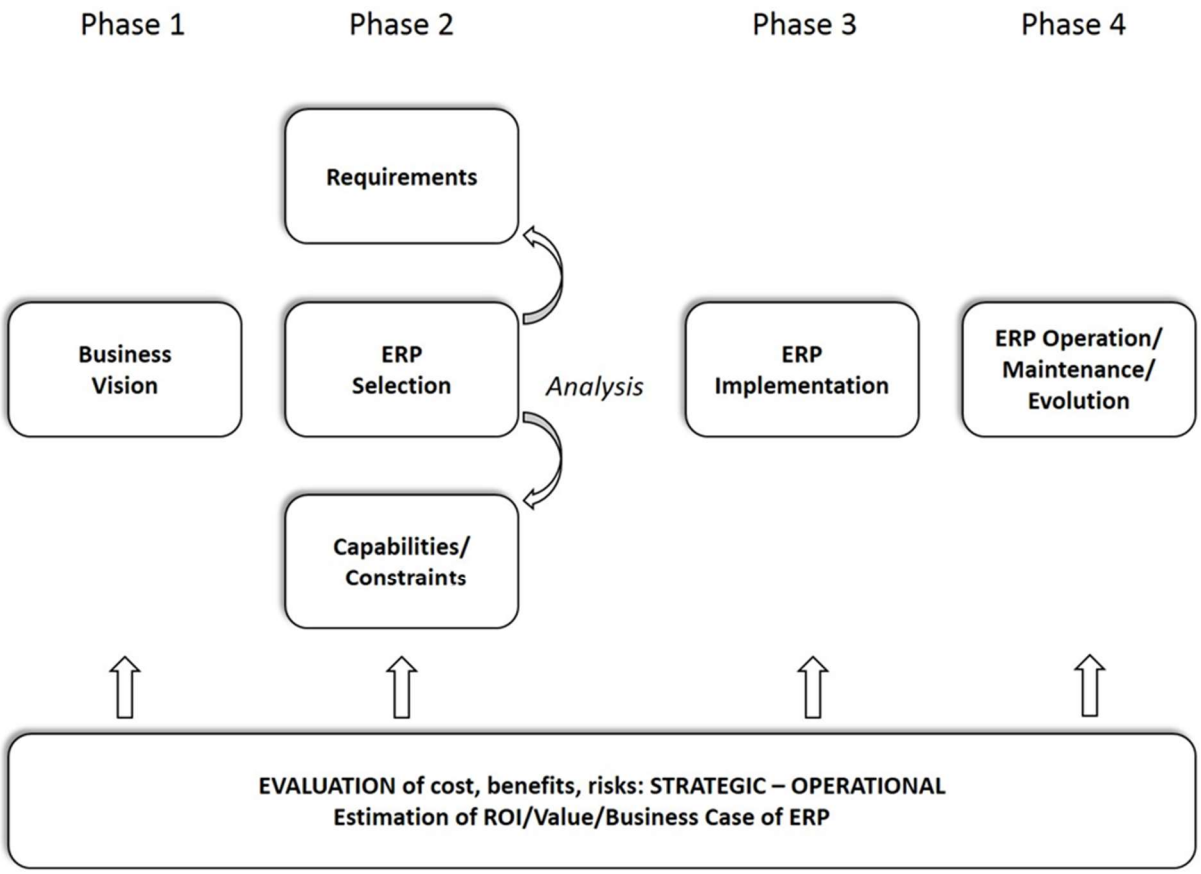

Figure 5. Major phases of ERP-life cycle

Source: Stefanou, 2001.

Another life cycle model of ERP systems presented by Esteves and Bohorquez, which was derived from a review of the literature from the years 2001-2005 which they conducted about ERP systems, is different, at first glance, from Stefanou's model. The phases in this model included: [1] Adoption decision phase, [2] Acquisition phase, [3] Implementation phase, [4] Use and maintenance phase, [5] Evolution phase, [6] Retirement phase (Esteves & Bhorquez, 2007).

However, it is possible to take these three models of life cycle as a basis for comparison (Table 1) following their significant influence on other contemporaneous researchers. The comparison of these models illustrates the resemblance between the principles of the division into phases by different researchers in different periods (Birfer, 2018).

Table 1. Comparison of phases of implementation by models (Cooper & Zmud, 1990), (Stefanou, 2001), (Esteves & Bhorquez, 2007).

Life Cycle Model / Phase	Cooper & Zmud (1990).	Stefanou (2001)	Esteves & Bohorquez (2007)
Number of phases	6	4	6
Pre-implementation phase	[1] Initiation stage.	[1] Business vision.	[1] Adoption Decision phase.
	[2] Adoption stage.	[2] Selection of an ERP software, vendor and implementation partner.	[2] Acquisition phase.
Implementation phase	[3] Adaptation stage.	[3] Analysis of the previous phases and implementation.	[3] Implementation phase.
	[4] Acceptance stage.		
System use phase	[5] Routinisation stage.	[4] ERP operation/maintenance/ evaluation.	[4] Use and maintenance phase.
Evaluation phase	[6] Infusion stage.	[4] ERP operation/maintenance/evaluation.	[5] Evaluation phase.
New system phase	-	-	[6] Retirement phase.

Source: own elaboration.

An additional similarity between the models mentioned was noted by Schniedrjans and Yadav, who reviewed research works performed in the first decade of the 21st century and reached the conclusion that these research studies focused primarily on case studies of the implementation process of ERP or emphasised and focused on one phase of the life cycle (Schniedrjans & Yadav, 2013).

The need for valid and methodical tools for the definition and measurement of the processes of selection and implementation led to methods that use critical factors. These methods focus the management's attention on the meaningful stages or traits of the running project and thus the achievement of the project goals with a higher likelihood of success. A common way of dividing these factors is according to the vector of their success or failure.

1.3 ERP systems success and failure factors

Critical success factors (CSF)[6] are the elements in the process of the choice and implementation of the ERP system that are significantly responsible for the success or failure of the project. These factors are primarily integrated in the stages and sub-stages of the life cycles and have been thoroughly researched. Every stage in the process of the implementation of the ERP system has a number of success factors and a level of criticality that changes according to the different research studies. In recent years, there have been a number of attempts to identify the CSFs and to unite them into one integrated model. Pastor-Collado and Salgado (2000) determined in their research work a number of patterns for the identification of CSFs. They suggested dividing the CSFs into four perspectives (groups): [1] Strategic, [2] Tactical, [3] Organizational and [4] Technological (Pastor-Collado & Salgado, 2000).

Another research study, performed by Somers and Nelson a year later, presented a list of 22 CSFs collected from a review of the literature, case studies, and surveys conducted in organizations (Figure 6).

[6] Often called KSF - Key success factor.

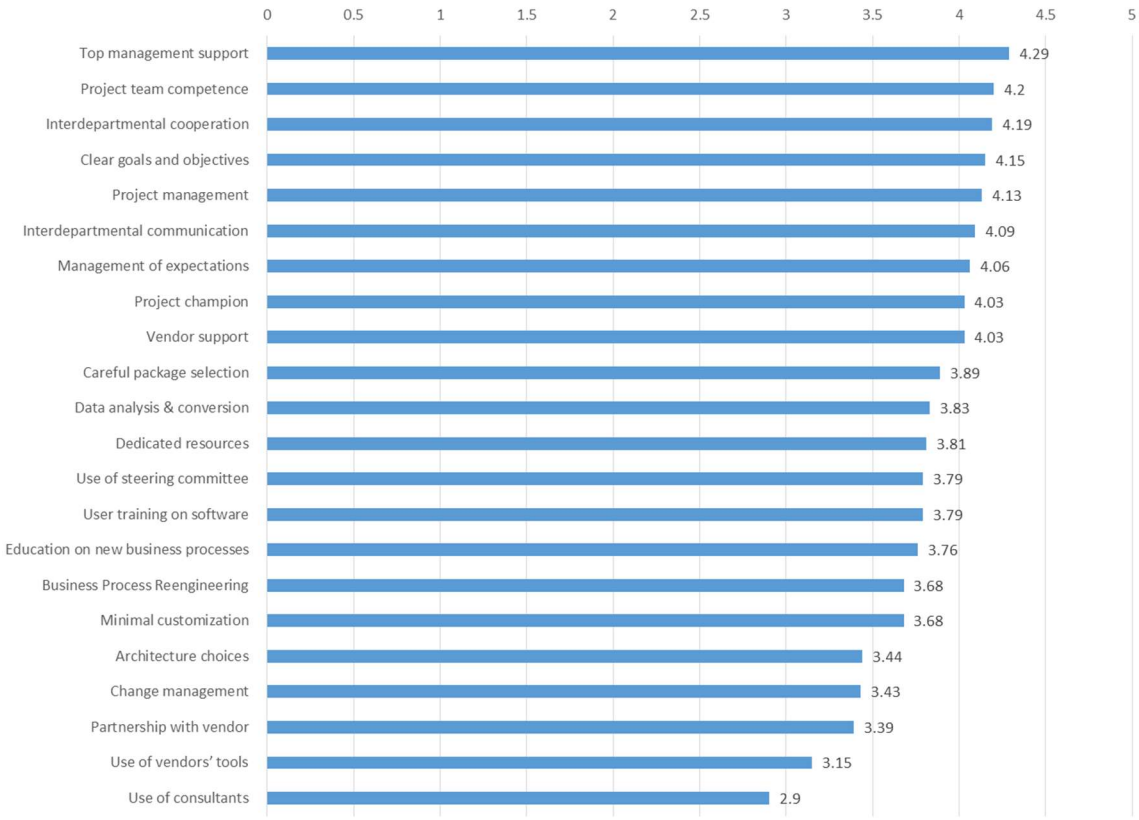

Figure 6. Mean rankings of CSFs by degree of importance in ERP implementation

Source: Somers & Nelson, 2001.

These factors were ranked, as presented, by the managers of 86 companies from a range of industries in different stages of implementation (Somers & Nelson, 2001). As part of the same research, the questionnaire results were sorted by the 6 implementation stages (as described by Cooper and Zmud and mentioned previously), in order to reveal the differences in the importance and influence of CSF's at every one of these stages (Figure 7).

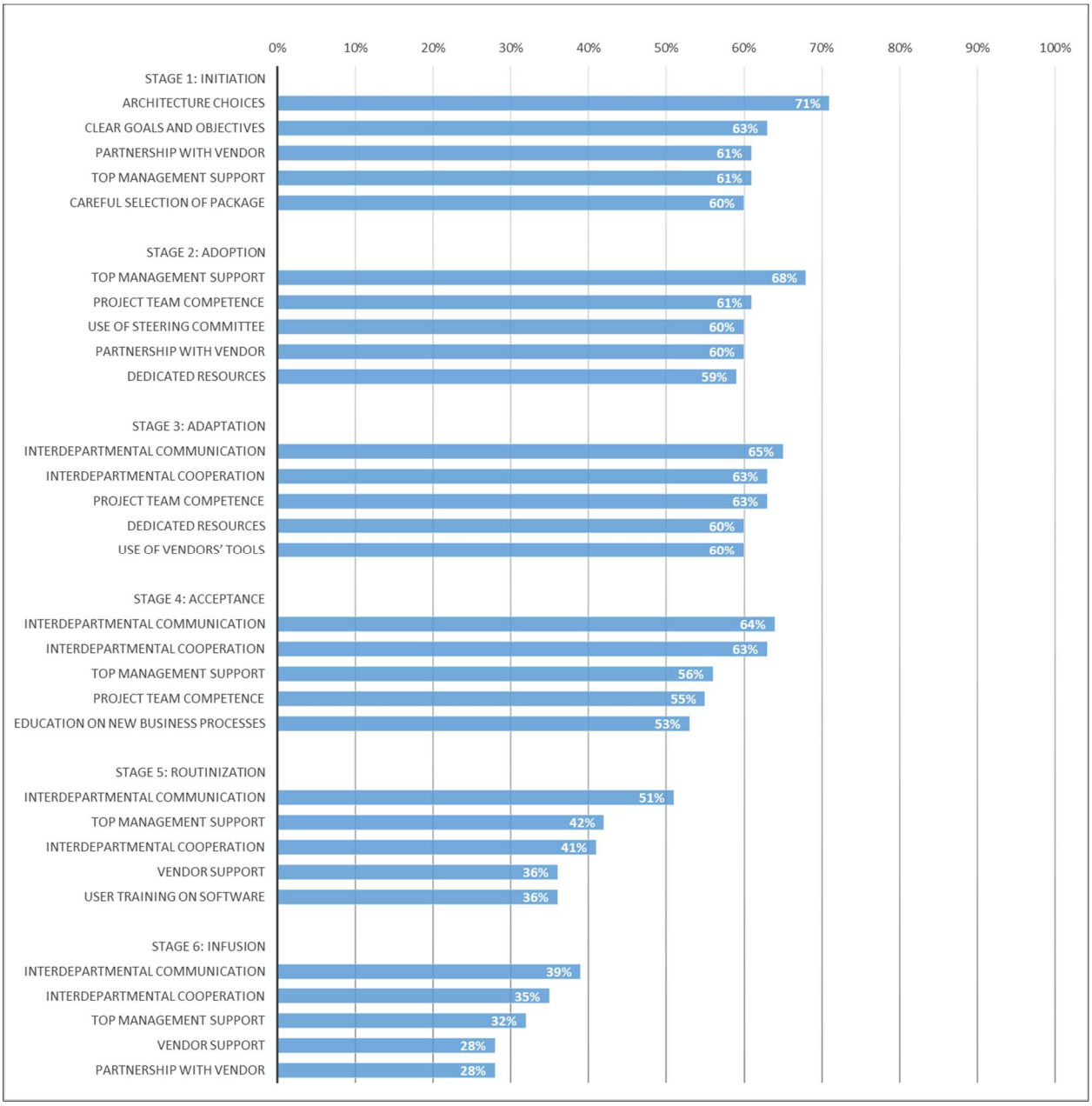

Figure 7. Top CSF's by ERP implementation stage

Source: Somers & Nelson, 2001.

The researchers Ram and Corkindalet (2014) reviewed more than 600 publications on CSFs between the years 1998 and 2010. In the analysis of the review of the literature, four groups of factors were revealed: [1] Organization-related, [2] Technological/ERP-related, [3] Project-related and [4] Individual-related. Each one of these groups includes 6 to 14 factors, while the selection of the ERP system was identified as a factor related to the project. The level of criticality of the CSFs, as presented by Hasibuan and Dantes (2012), shows the relative importance of every factor divided into the different life stages. The selection of a strong ERP

product in the stage of the selection of technology, which constitutes a component of factors related to the project, as described by Ram & Corkindalet (2014), has a most critical influence on the success of the implementation, along with communication and determination of the methodology for the implementation of the ERP (Hasibuan & Dantes, 2012). Additional success factors, less critical, which were noted in the stage of the selection of the technology in the review, are the use of a consultant, the determination of an ERP implementation strategy, management of risks and technological infrastructures.

Conversely, the critical failure factors (CFF) have also been anlysed. The research of Wong, Scarbough, and Davison reveals 14 factors with direct influence on the chances of successful implementation and emphasizes a number of them. In this research study, the researchers analysed four different test cases on ERP projects that ended with failure in global companies in different areas (Wong, Scarbough, & Davison, 2005). Another research study performed by Gargeya and Brady on a SAP[7] ERP system implementation project compared the roles of 6 factors in 29 successful and 15 failed projects. The research study shows that the factors which have significant influence on success will not necessarily have the same influence on failure and vice versa. Therefore, it is recommended to focus on a different group of factors so as to achieve success or to reduce the chances of failure (Gargeya & Brady, 2005).

The identification and creation of uniformity between the different CFFs is a true challenge for researchers. One of the proposed methods is Failure Mode and Effect Analysis (FMEA). FMEA enables the identification and analysis of the potential weak points and failures of a functional, design, or process related character. This methodical model can serve as a basis for the choice of the approach most suitable for the management of the project. It is possible to apply it before the start of the project through reports from similar projects that have already ended or are still in progress. The application of FMEA on a project for ERP system implementation was proposed by Yang, Ling, Lin, and Huang (2006) and was later described by Shirouyehzad (2009) and Zitar (2014).

The process of choosing the most suitable ERP system is one of the factors of success with greatest influence on the ERP implementation project (Hasibuan & Dantes, 2012).

[7] An ERP system developed by the German company SAP SE, a leading company in the global market of systems providing ERP. In 2015 SAP was chosen by 39% of all ERP clients (ERP Report: Panorama Consulting Solutions, 2015).

Consequently, it is described by a wide variety of articles and research studies. Many of them focus on one of the popular models of decision making and offer a closed list of criteria. The compatibility of these proposed processes with each other is deficient. Moreover, each one of them proposes different criteria or another perspective regarding the weight of a similar factor.

1.4 Conclusion

The ERP system evolved from MRP and MRP II information systems in the 1990's and was the first to offer an overall integrated system including financial, logistic, production and HR management modules. The flow of data using one united database enabled the full integration of these modules and created, for enterprises, the ability to implement an end-to-end computerized on-line business process. ERP implementation is a high-risk project where quality of management is extremely important. Organizations need to learn to identify the significant factors that influence the implementation process to effectively address them in order to meet the budget targets and time frames defined during the planning stages. As the review shows, a high percentage of organizations report overruns in these two critical issues, and this trend has barely changed over the years.

There are several popular implementation strategies described in the literature and the main difference between them is the pace of the progression to put into action the whole assortment of the ERP modules and the various features it comprises.

These strategies exist on a scale between phase by phase implementation (and its variations) on one extreme and "big-bang" implementation on the other. Each one of these strategies has its own benefits and limitations. There is no specific recommendation for the selection of a strategy, but in most cases it relies on organizational (or consultants') will and management decisions.

Over the past decades, a large number of models for the life cycle of the process of implementation of an ERP system have been proposed. The models include stages considered as the main milestones of the process. These models rely on surveys and case studies, as well as on the logical assumptions of the developers of the models themselves. Therefore, they are different in many aspects, such as the description and the number of stages. However, it is possible to find considerable similarity between the models.

Therefore, many attempts have been made to propose a generic model. However, there is still no accepted and agreed-upon model for the stages of the life cycle. To emphasize the role and importance of certain factors through the flow of the stages of the life cycle, factors of success and factors of failure have been identified. Many different research studies, surveys, and case studies have revealed a range of factors of different order of influence on project success or failure. Frequently, in different publications, one factor of success is determined as a factor of decisive importance to the project's success, but an accepted list of factors and their weight has not yet been identified. One of the factors appearing consistently as significantly influencing the success of the implementation of the ERP system is the process of the selection of the system. A direction for further research is the integration of CSFs and methods of multi-criteria decision making that have the ability to take into account many criteria and their importance.

The present research study reviewed the relevant literature in two aspects of the process of implementation of an ERP system – the life cycle and the critical factors of success and failure. The common denominator of these two aspects is the variety of the models and opinions, and the lack of acceptance and agreement on a uniform approach. To reduce this gap, it is necessary to perform another research study contributing towards the development of a comprehensive and inclusive approach that will be widely accepted and will serve as a solution to the difficulties of the implementation of ERP systems.

2 Systematic comparison of ERP selection managerial decision making methods

2.1 Introduction

The ERP implementation project is characterized by many organizational changes, crossing management areas, complex structures, high costs and tight schedules. Thus, the implementation project of a new ERP system is a potential threat to the financial stability of the organization (Ahituv, Neumann, & Sabrin, 2002). Various factors have been recognized over the years as relevant to the success or failure of the ERP implementation project. Some are more critical than others. One of the possible and chronologically early points of potential risk is the ERP software selection process. When the stakes are so high, the result of a discrepancy between the selected system and the organizational needs can be fatal.

In order to minimize the risks originating from a system selection made by managers which is not optimal, many researchers have tried to overcome this problem using selection methods. Most of these studies of methodological approach suggest the use of Multi Criteria Decision Making methods. The MCDM methods are mathematically driven models of the managerial decision making process. These models have different levels of mathematical complexity and often suffer from limitations in terms of qualitative analysis.

2.2 Management science decision making theories' integration into the selection process

2.2.1 Decision making theories in management science

The traditional division of decision making theories made in management science is into Normative, Descriptive and Prescriptive types. The normative theory can be defined as the search for the optimal decision based on the taking into account of a rational set of factors. It should use accurate data and carefully well-founded and trustworthy information. The decision-maker should be impartial and make the optimal information-driven decision without bias. Any psychological and personal influences should be neutralized. These terms, mainly non-realistic in practice, make normative theory more of a pointer towards the optimal direction and not a road map for most of the actual cases of decision making. On the pros side, this theory is targeted on delivery of a deeply analysed, fact based best objective decision which is a bright lighthouse for creating decision support systems. In view of normative theory, it can be assumed that complex organizational problems of decision making under conditions of partial or total uncertainty, together with the natural human difficulty of making an

objective and absolutely rational decision, will prevent the optimal decision from being made for the organization.

The descriptive theories are more oriented towards the human factors of the decision-maker, taking into account psychological and environmental issues. These theories do not ignore the uncertainty of the information used during the decision process and the personal characteristics of the decision-maker (Luce & Winterfeldt, 1994). It is considered more realistic and closer to real-world practice. The pioneer of this theory was Herbert A. Simon in his book *Administrative Behaviour* (first edition published in 1947), which presented his concept of administrative theory for a decision-making process that includes a more realistic description of how managers make decisions in the real-world compared to what is described in normative theory. Generally, there are several management theories which try to describe the organization and its structure. Among these theories are the classical - scientific management approach, the bureaucratic approach and aforementioned administrative theory, neoclassical theory and modern organizational theory which includes – the systems approach, the socio-technical approach, the contingency or situational approach and others (Asopa, 1997; Sapru, 2008). The basic assumption of Simon's theory, which emphasized the decision making perspective, is that since there is uncertainty in organizational reality, decision makers will try to make a satisfactory decision rather than the best one since they do not have the cognitive ability to perform the best decision making process. To achieve this adequate decision, managers often simplify the reality and even ignore various aspects and factors that are relevant to the decision because they are not able to consider them in their decision making process. According to Simon's theory, a decision that meets the threshold of bounded, limited rationality is not the optimal one, from the organizational point of view, but the one that meets minimum requirements that match the required level of ambition, considering the natural limitations of schedule and budget. In addition, even if the decision maker wants to make the most rational decision and thus reach the optimal decision for the organization, there will always be factors such as administrative, cognitive, environmental, and perceptual constraints as well as budget and schedule constraints that prevent him from achieving it perfectly.

Another problem that arises from this theory is the tendency of people to analyse new information and data according to old standards, which are familiar to them, which actually

fixes them within a particular conceptual framework (Simon, 2013). In his theories, Simon introduced the basis for decision support systems (DSS) including four main stages – Intelligence, Design, Choice and Review. It is actually a model of the human decision making process (Pomerol & Adam, 2004). The intelligence stage concentrates on the collection and identification of decision relevant data. The design stage includes the generation of alternatives based on the data retrieved in the previous stage and comparative criteria definition followed by analysis of each one of the alternatives. The choice stage is the decision about the selection of the best alternative of those generated in the previous stage. The selection is made via the use of criteria by which the alternatives can be compared. The review stage is used to examine the results of each previous stage, when or after it occurs, checking, for example, whether the data collected was sufficient enough and whether there is a satisfactory alternative among the proposed options (Simon, 1960). This kind of repeating review process during the flow of decision making is a key element in this model and what makes it iterative and as a result widely used in information systems decision making processes including its selection (Adam & Pomerol, 2008).

With that being said, most of the theories are not exclusively descriptive or normative but more of a mixture of them. An example of such fusion is the prescriptive theory which integrates the theoretical basis of the normative theory and aspects of the descriptive theory which can relate to more realistic decision making processes (Aliev, Pedrycz, Kreinovich, & Huseynov, 2016). Current research concentrates on the decision making process of ERP system selection. The selection process of an information system, by nature, has an important element of quantitative data regarding the alternatives which allows one to make use of normative theories requiring accuracy and a rational set of factors. On the other hand, the description of internal and external organizational environment, consultants' agendas and managers' personal characteristics can be more suitable to descriptive theory definitions. Factors of both of these theories from the perspective of the selection process will be explained and analysed in the following chapters.

2.2.2 Decision making and selection process

The trend in recent years in the decision making field is to combine the human ability to solve non-standard problems with the capabilities of the standard methods and computer

modelling. Information systems offer extensive decision support tools (DSS) that can help the manager to moderate risks and make good decisions. The standard tools use a wide spectrum of methodologies for the decision and selection process.

The decision making procedure can be defined as a narrowing down of a set of alternatives to the possible minimum, comparing and ranking them and as a result some of them are accepted and others rejected. The comparing and ranking is carried out via the use of preference of criteria (Ehrgott, Figueira, & Greco, 2010).

MCDM's origins go back to the operations research discipline dedicated to solving subjective criteria evaluation issues. Beginning in the 1960's, MCDM has developed as a standalone research area concentrating on the selection process of an optimal alternative, including classification and ranking (Mardani et al., 2015).

All the methods which assist the decision maker in the selection process in cases with multiple conflicting criteria are generally called MCDM. The MCDM method can be described as a multi-phase process including dismantling complicated decisions into minor elements to be weighted and ranked as a separate component. The process ends by combining the results into a general conclusion regarding the decision to be taken. MCDM methods often use discrete alternatives and a closed list of criteria to be weighted. (Zionts, 1981).

A decision making process using MCDM methods is structured differently depending on the method applied but can be generalized into three major steps (Figure 8).

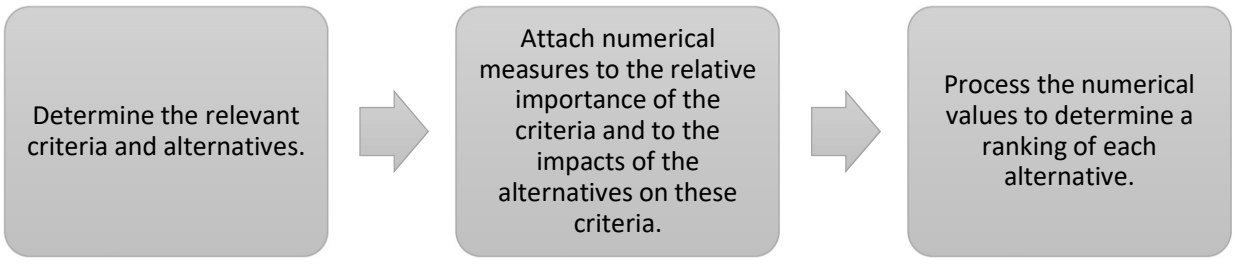

Figure 8. Steps of the decision making process via the use of MCDM methods

Source: Triantaphyllou, 2000.

The criteria can meet a variety of definitions, for example, they can be cardinal or ordinal, exact or fuzzy, specific or range based. The most updated MCDM versions allow this variety as part of the method. The following general example (Figure 9) demonstrates a hierarchical structure of an MCDM alternative evaluation and selection method.

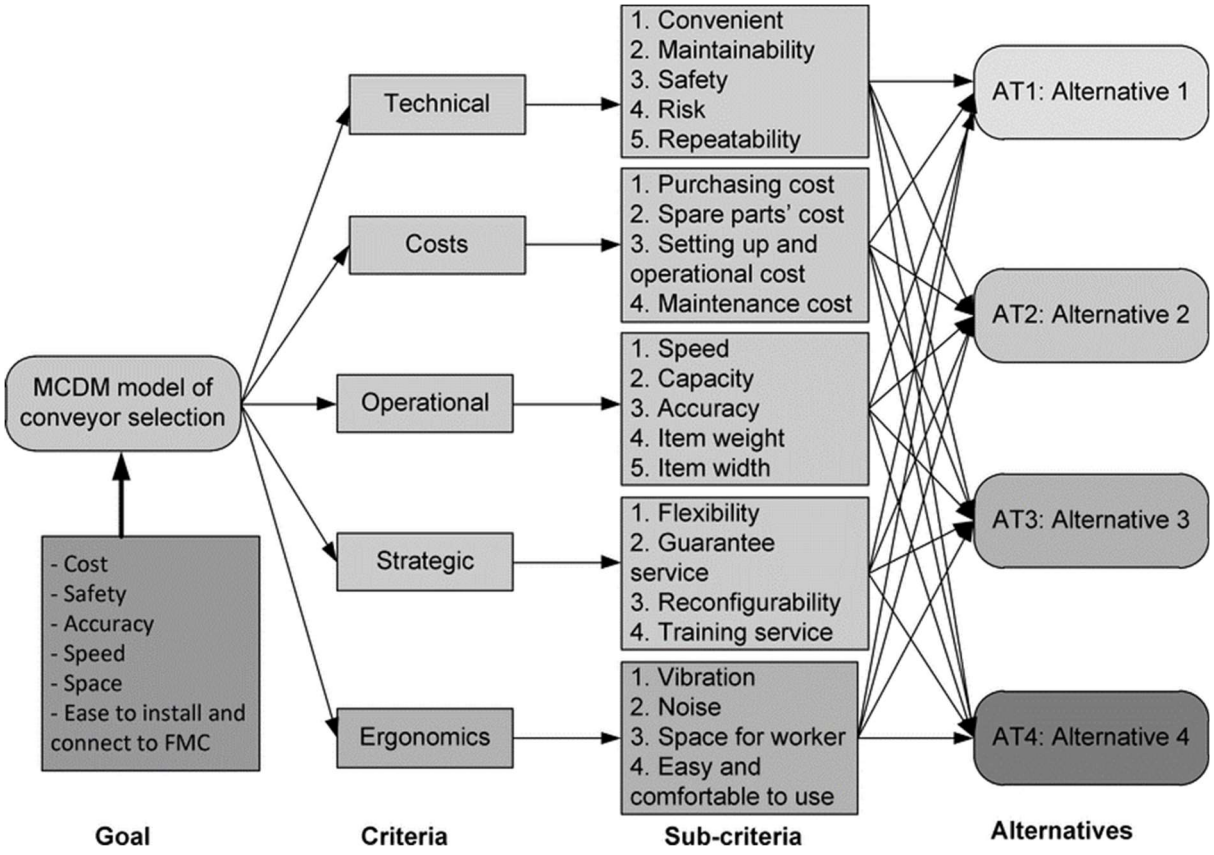

Figure 9. General example of MCDM hierarchical structure: the MCDM for conveyor evaluation and selection

Source: Nguyen, Dawal, Nukman, Rifai, & Aoyama, 2016.

The current chapter is a review and analysis of ERP system selection processes and the use of MCDM methods. The research part of the chapter is intended to identify and review influential publications describing the application of MCDM on the ERP system selection process. Trends in the use of MCDM methods will be demonstrated using comparative analysis.

An introduction to the MCDM methods often used in the ERP system selection process will be followed by an analysis of the literature review of various MCDM methods, their acceptance and frequency of application for selection of an ERP system.

2.3 ERP systems' selection process. Applications of MCDM methods.

One of the most influential factors in ERP system implementation project success is the system selection phase (Hasibuan & Dantes, 2012). This phase has been researched extensively over the years. Most of the studies use one of the MCDM methods and a closed criteria list to try to get a reliable result. The efficiency of these processes is not high, each study suggesting a different concept of criteria ranking and weighting but there is no one agreed path with a proven positive result. Another group of methods used for the ERP system selection process uses the hybrid approach to try and combine different methods and models in such a way that they complement each other. For example, they use different MCDMs for qualitative and quantitative criteria. Dozens of custom and original methods are also suggested by various researchers but in most cases there is no continuity, by other researchers, in this field of study. The reviewed literature indicates that there are several leading methods, some of them based on fuzzy logic, often used in the ERP system selection process.

The Analytic Hierarchy Process (AHP) was one of the first MCDM methods to become widely known. Published by Saaty in 1980, it gain popularity as an MCDM and was later modified and suggested as a method for the selection of information systems in general and ERP systems in particular by numerous researchers (Wind & Saaty, 1980). One of the methods suggested as a modification was the AHP combined with the Nominal Group Technique (NGT) (Teltumbde, 2000). AHP is a three-stage model, including decomposition (development of the AHP hierarchy of criteria), comparative judgments (utilization of paired comparisons between the criteria by using a nine-point scale) and synthesis of priorities (a paired (pairwise) comparison process is repeated for each attribute). The results of the lower levels are summed up in the hierarchy. The advantages of the method are the ability to use multiple criteria in the decision making process, allowing fuzzy definitions of criteria. Qualitative and quantitative evaluation and group decision making are also allowed. This list of possibilities shows that the method is flexible and can be used with different given prerequisites (Forman & Gass, 2001). The main disadvantages of the AHP are: consistency is assumed and cannot be proven in the

evaluation process; there are some problems in using the method when a large group of criteria is being used or when the overall amount of criteria is changed on the go, increasing or decreasing the number.

As a result of these and other cons of the AHP, it was modified by Saaty, as an evolution of his own methodology. The ANP, Analytic Network Process, allowed reciprocal relations between all the hierarchy levels and the calculations of the ANP were done by using the "Supermatrix" concept that enabled interdependencies between attributes (Saaty, 2004).

In order to overcome problems emerging from the difficulties in defining the criteria in an unambiguous way, fuzzy solutions were suggested for many of the MCDM methodologies including AHP and ANP. Applied to these methods, the fuzzy approach provided an option to analyse both quantitative and qualitative criteria when there was uncertainty during the selection process (Junior, Osiro, & Carpinetti, 2014). The fuzzy logic was first introduced in 1965 by Zadeh who also suggested it could be used by other methods which lack the flexibility of analysis under conditions of uncertainty (Zadeh, 1965; Zadeh, 1994). The research suggested applying the fuzzy approach to any used method and thus benefitting from both methods simultaneously. As a result, the fuzzy approach for AHP was introduced by Chang in 1996. The concept suggested using linguistic variables to indicate the comparative judgments made by decision makers of an organization using the three-stages of the AHP methodology (Chang, 1996). The ERP selection process application of fuzzy AHP was suggested by Cebeci with the intention of reducing uncertainty in the evaluation of criteria. The drawback of this application was the inability to be efficient during all phases of the ERP selection and implementation process (Cebeci, 2005).

Combinations of the fuzzy and classic approaches have become popular in recent years. They have been thoroughly researched and often preferred to the classic methods in practice. Combinations of different fuzzy methods have also had a notable share in this field of study (Enea & Piazza, 2004), (Mohanty, Agarwal, Choudhury, & Tiwari, 2005), (Ayağ & Özdemir, 2007), (Ghapanchi, Jafarzadeh, & Khakbaz, 2008) , (Kahraman & Büyüközkan, 2008), (Cebeci, 2009), (Rao & Rajesh, 2009), (Yang & Qin, 2009), (Şen & Baraçlı, 2010), (Yang & Zhao, 2010), (Nikjoo, Khah, & Moghimi, 2011), (Junior, Osiro, & Carpinetti, 2014), (Efe,2016). A fuzzy ANP method was used by Mikhailov and Singh in decision support system development in order to minimize the uncertainty of the process (Mikhailov & Singh, 2003). ERP selection methodology

using Fuzzy ANP was suggested by Ayağ and Özdemir, who also defined a framework of criteria, dimensions and attributes modifying them with a fuzzy sets method application (Ayağ & Özdemir, 2007).

Another method used for ERP selection known as Data Envelopment Analysis (DEA), was developed by Cooper and Rhode. The DEA used decision making units (DMU's) to measure the discrepancy between the input and output criteria efficiency. The original study suggested using a set of weightings that can reflect the most correlative efficiency score (Charnes, Cooper, & Rhodes, 1978). A study using the DEA method for evaluation and selection of an ERP system which was conducted by Lall and Teyarachakul suggested the use of sets of system attributes criteria and vendor attributes criteria (Lall & Teyarachakul, 2006). A fuzzy application of DEA efficiency measures, which was first suggested as a general method by Kao and Li (Kao & Li, 2000), was suggested as an ERP system selection method by several researchers later on (Ghapanchi et al., 2008), (Yang & Qin, 2009), (Yang & Zhao, 2010).

The Quality Function Deployment method (QFD), developed by Akao (1997) for the Japanese automotive industry and later modified by others, had the main idea of translating the customer's requirements into the final product or service characteristics and prioritizing them by the use of a "Quality House" matrix that demonstrates the relationship between customer requirements and technical requirements, priorities and limitations. The additional benefit of the QFD as an ERP system selection method is its ability to identify the level of compatibility of the system's attributes to the enterprise requirements (Içtenbas, Rouyendegh, & Erkan, 2012). The QFD method was applied in combination with fuzzy sets. This combined method was used for transforming the unfocused and imprecise inputs of system requirements into clear coherent information (Chan & Wu, 2002). ERP system selection process application of the fuzzy QFD study was carried out by Sen and Baracli. Its concept was the grouping of functional and non-functional criteria and its weightings of importance followed by their prioritization by suitability to the organizational requirements (Şen & Baraçlı, 2010). Another combined method was presented by Karsak and Ozogul, who suggested integration between QFD, fuzzy linear regression and goal programming MCDM methods (Karsak & Özogul, 2009).

Another popular method of MCDM is Goal Programming (GP), its main feature being the ability to treat multiple objects at the same time during the evaluation process and supply a set of solutions.

A criticism of the model is the need to define the goal value for each objective, referring to the incomplete data and limited information that decision makers often possess. Another aspect the GP has been criticised for is the absence of quantitative representation of the qualitative objects (Ramanathan & Ganesh, 1995). The fuzzy GP method was intended to solve the last issue (Chen & Tsai, 2001). Trying to overcome these weak points, the GP is often combined with at least one other fuzzy and classic MCDM method, when used for the ERP selection process. Generally, the GP method can be used together with other methods to perform simultaneous analysis and ranking of criteria and alternatives (Badri, Davis, & Davis, 2001), (Karsak & Özogul, 2009), (Nikjoo et al., 2011).

Another MCDM method, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), evaluates criteria by using weightings, ranking the alternatives by their range from ideal to the worst alternative. The relative simplicity of the method and its intuitive framework is an important advantage, especially when compared to other methods. The criticism of the method is focused on its numerical valuations; however it can be resolved via the use of fuzzy TOPSIS and linguistic variables (Efe, 2016).

ELECTRE and PROMETHEE are outranking methods often discussed in the reviewed studies referring to the applications of the above on the ERP system selection process.

ELECTRE (Elimination and Choice Expressing Reality), includes a family of methods which are a further development of the original method (ELECTRE I, ELECTRE II, ELECTRE III, ELECTRE IV, ELECTRE IS, ELECTRE TRI). This is a two-phase analysis that creates a set of other outranking alternatives not included in the set and then prioritizing them by the relative importance within the set using weighted criteria. These methods are mainly used as the first stage of the evaluation process followed by other MCDM methods that can add more efficiency (Daher & de Almeida, 2013), (Figueira, Greco, & Słowiński, 2013).

PROMETHEE, Preference Ranking Organization Method for Enrichment of Evaluations is a pairwise comparison method used on all selection alternatives for each criterion, creating

relationships among them and ranking them at the end of the process. Similar to ELECTRE, it has been used as one of the parts of a combined ERP selection method (Rao & Rajesh, 2009).

One of the examples of such use is the PROMETHEE and ANP methods combination for SME's ERP system selection (Kilic, Zaim, & Delen, 2015). Other MCDM methods that have been used for the ERP selection process were described in the reviewed studies listed below.

- VIKOR - Multi-criteria Optimization and Compromise Solution (Lin, Tzeng & Jen, 2005),
- GRA - Grey Relational Analysis, which is a fuzzy model extension (Feng, 2007) ,
- SMART - Simple Multi Attribute Rating Theory (Olson, 2007),
- Holistic approach (Bakås, et. al. 2007),
- FAD - Fuzzy Axiomatic Design method (Celik, 2008).
- Fuzzy Neural Network - non mathematical fuzzy decision model (Jianhua, Shugong, Guangfeng, & Chunrui, 2010)
- Intuitionistic Trapezoidal Fuzzy sets, which is another extension of the fuzzy sets method (Chen, 2011)

Further to the above, combinations of various MCDM methods are often used to minimize the effect of the weak points of each one of the single methods. In many cases, one of the methods used in the combination is defined for evaluation in the first phase of the decision making process, converting and modifying qualitative and linguistic data into quantitative, measurable data. The second phase is to focus on the ranking and prioritizing of criteria used in the selection process and the quantitative data processing followed by analysis.

2.4 Comparative analysis of MCDM methods applications for an ERP system selection process

This part of the chapter demonstrates the tendencies of MCDM methods application for an ERP system selection process in recent decades. The purpose of the described research is to identify the inclinations of the research in this field by means of comparative analysis of the course of study, in order to provide essential information for the further ERP system selection study process (Brzozowski & Birfer, 2017).

2.4.1 Literature research methodology

After completing the literature review, the findings were analysed. Terms were identified as often being used in studies describing the MCDM method of an ERP system selection process.

In the next stage, these search terms were used for recognizing the relevant publications. The list of terms included:

- MCDM
- MCDA
- Planning System

These terms were combined with the next list of terms and used, followed by the specific names of the MCDM methods covered in the literature review.

- Method
- Approach
- Evaluation
- Selection
- ERP system
- Enterprise Resource Planning System

The range of publications dates was confined to between 2000 and 2016 in order to keep the research in the study up to date.

The search process was carried out using the Harzing "Publish or Perish" software (Harzing, 2007) which uses scholar.google.com as its database. The search was performed on 16 August 2016 and conducted by this thesis author. The results were checked and duplicate publications by the same authors, such as conference reports on the published research, were removed. The final list of publications was reviewed and sorted by the MCDM method issued. The sorting and grouping phase is described in more detail in the results section. A number of publications were found after the analysis of the references of the publications that met the search criteria in the previous phase.

The data that was collected included the year of the publication and the number of citations on the search date. In the next stage, the findings were processed and the abstract of each one of them was analysed. The findings were then sorted and grouped according to two criteria, A and B.

Grouping according to Criterion A reflected the specific MCDM method used in the research that is being sorted. Criterion A is described in Table 2 below. Grouping according to Criterion B classified the reviewed publications by their pertinence to the following groups:

- "Classic" - research that described the application of commonly used MCDM methods
- "Fuzzy" - research that used a combination of the classic MCDM method with the Fuzzy sets approach.
- "Integrated" - for research which used integration or combined more than one MCDM method in their studies.
- "Other" which contains the MCDM methods that were developed and used only within the reviewed research or an MCDM method not included in any of the other groups.

Table 2. The MCDM methods grouping and types of publications included.

MCDM methods grouping according to criterion A	**MCDM methods grouping according to criterion B**	**Types of publications included in the group**
AHP	Classic	AHP application, research and case studies.
ANP		ANP application, research and case studies.
DEA		DEA application, research and case studies.
ELECTRE		ELECTRE application, research and case studies.
QFD		QFD application, research and case studies.
TOPSIS		TOPSIS application, research and case studies.
Fuzzy AHP	Fuzzy	Fuzzy AHP application, research and case studies.
Fuzzy ANP		Fuzzy ANP application, research and case studies.

Fuzzy DEA		Fuzzy DEA application, research and case studies.
Fuzzy GP		Fuzzy GP application, research and case studies.
Fuzzy QFD		Fuzzy QFD application, research and case studies.
Fuzzy TOPSIS		Fuzzy TOPSIS application, research and case studies.
INT AHP	Integrated	AHP (w/ or w/o fuzzy sets) integrated or combined with any other MCDM application, research and case studies.
INT ANP		ANP (w/ or w/o fuzzy sets) integrated or combined with any other MCDM application, research and case studies.
INT GP		GP (w/ or w/o fuzzy sets) integrated or combined with any other MCDM application, research and case studies.
INT PROMETHEE		PROMETHEE (w/ or w/o fuzzy sets) integrated or combined with any other MCDM application, research and case studies.
INT QFD		QFD (w/ or w/o fuzzy sets) integrated or combined with any other MCDM application, research and case studies.
INT TOPSIS		TOPSIS (w/ or w/o fuzzy sets) integrated or combined with any other MCDM application, research and case studies.
Other	Other	MCDM developed and used only within the reviewed research or an MCDM used very rarely in the ERP system selection process.

Source: own elaboration.

2.4.2 Results of literature research

After performing the search process as described, 189 publications were picked and reviewed. In the sorting process, the publications were divided into 19 groups of MCDM according to the logic of criterion A (Table 2).

The findings (Table 3) indicate that the tendency of applying an MCDM method to the selection of an ERP system increased from 2005 and reached its peak in 2012. The majority of publications focused on the AHP, Fuzzy AHP and AHP integrated with other MCDM methods.

Another phenomenon is the large amount of unique MCDM applications suggested by a variety of researchers as a possible solution.

Table 3. MCDM publications by criteria A and B grouping (publications count per year).

MCDM type (criterion A and B grouping)	Year of Publication																
	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
AHP	-	-	1	1	3	2	1	2	2	1	1	4	3	1	-	-	22
ANP	-	-	-	-	-	-	-	1	2	-	1	-	-	1	-	-	5
DEA	-	-	-	1	-	1	-	1	-	-	-	2	-	-	-	-	5
ELECTRE	-	1	-	1	-	-	1	-	1	-	-	-	1	-	-	-	5
QFD	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	4
TOPSIS	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Classic total	0	1	1	3	3	3	2	4	5	2	2	9	4	2	1	0	42
Fuzzy AHP	-	-	-	-	1	-	1	2	2	5	1	3	1	2	1	-	19
Fuzzy ANP	-	-	-	-	-	-	2	3	-	-	-	-	-	1	-	-	6
Fuzzy DEA	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	3
Fuzzy GP	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Fuzzy QFD	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Fuzzy TOPSIS	-	-	-	-	-	-	-	-	1	-	1		1	2	-	1	6
Fuzzy total	0	0	0	0	1	0	3	6	4	7	2	3	2	6	1	1	36
INT AHP	-	-	-	-	1	1	1	2	1	3	1	5	1	3	-	2	21
INT ANP	-	-	-	-	2	-	-	1	-	-	2	4	-	-	1	1	11
INT GP	-	-	-	-	1	1	-	-	1	-	2	1	-	1	-	-	7
INT PROMETHEE	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1	3
INT QFD	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
INT TOPSIS	-	-	-	-	-	-	-	1	-	1	2	1	-	-	-	2	7
Integrated total	0	0	0	0	4	2	1	5	3	4	7	11	1	4	2	6	50
Other	1	-	-	2	3	3	6	3	7	7	5	5	6	7	5	1	61
Total	**1**	**1**	**1**	**5**	**11**	**8**	**12**	**18**	**19**	**20**	**16**	**28**	**13**	**19**	**9**	**8**	**189**

Source: own elaboration.

The decreasing amount of studies in recent years (Figure 10) could imply that the suggested MCDM approaches provided an adequate solution to the issue, although no evidence of a widely accepted approach was noted.

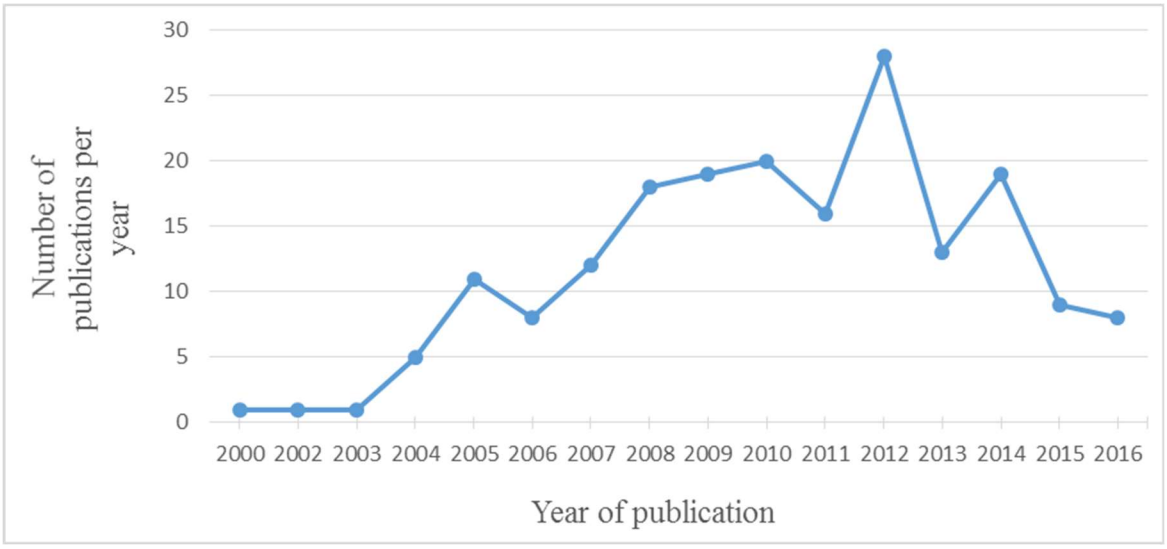

Figure 10. Dynamics of MCDM publications (total of all groups of criterion A)

Source: own elaboration.

From the analysis of the number of citations per publication, for each one of the MCDM methods, grouped according to criterion A during the discussed period, it can be noted that AHP, fuzzy AHP and integrated AHP have a cumulative 41% of all cited MCDM methods in the reviewed literature (Figure 11). This high percentage can be explained by the early appearance and high popularity of the general AHP approach, which gave enough time and material for other researchers to develop a dedicated method to apply to the ERP system selection process. Another reason can be the AHP approaches' suitability for dealing with the selection process of an ERP system, probably due to its capability to deal with qualitative and quantitative data, which is one of the most common drawbacks of the other MCDM methods.

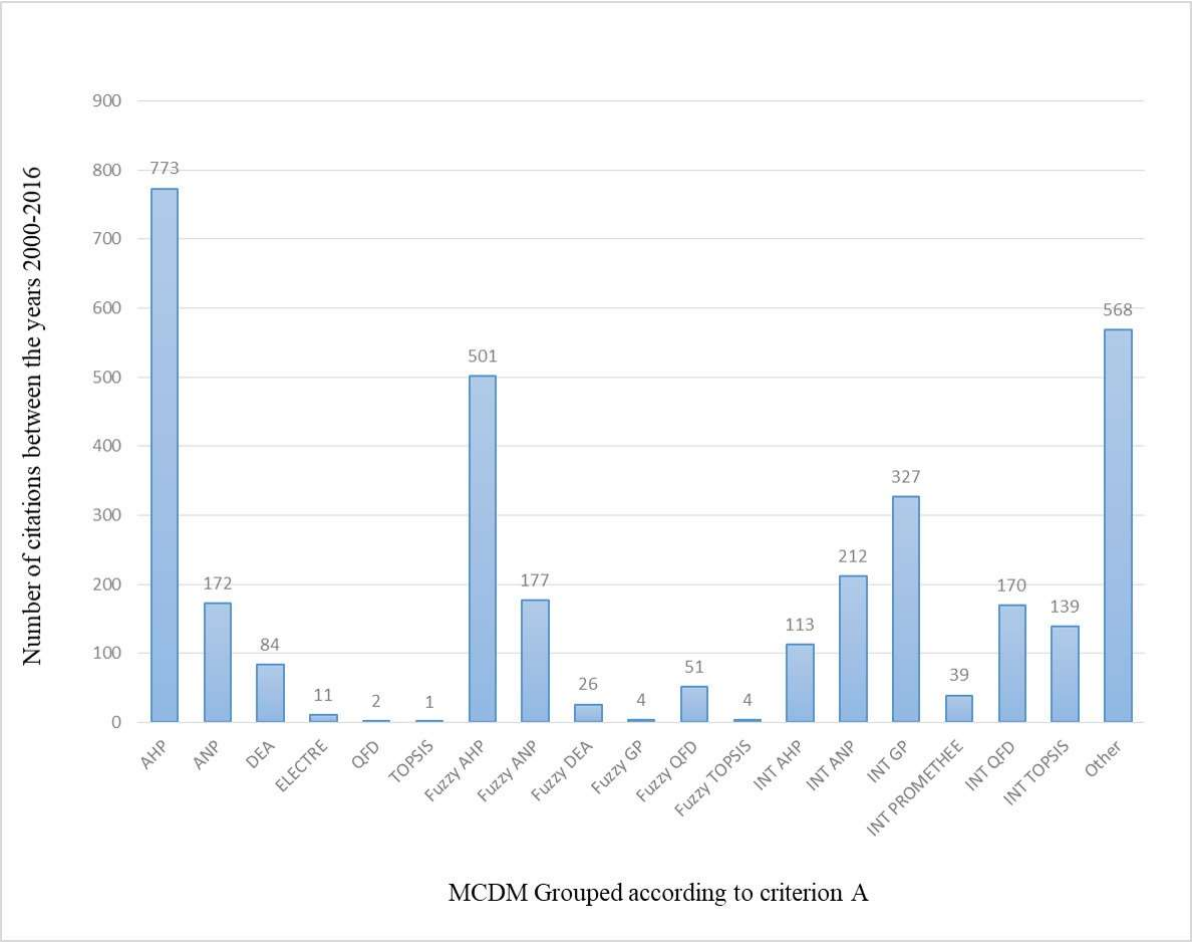

Figure 6. Publications cited by between the years 2000-2016 (grouped according to criterion A)

Source: own elaboration.

Analysis of the results of the cited publications grouped according to criterion B (Figure 12) shows that over 52% belong to fuzzy and integrated MCDM approaches. Taking into account that fuzzy sets applied to classical MCDM methods are already a type of integrated approach and publications grouped under “Other” often also suggest integrated approaches, it can be concluded that the concept of integration between different MCDM methods gained considerable popularity. This need to combine can be justified by the limitations each MCDM method has in various aspects and phases of the method and their inability to deal with the complexity of the selection process within one specific model.

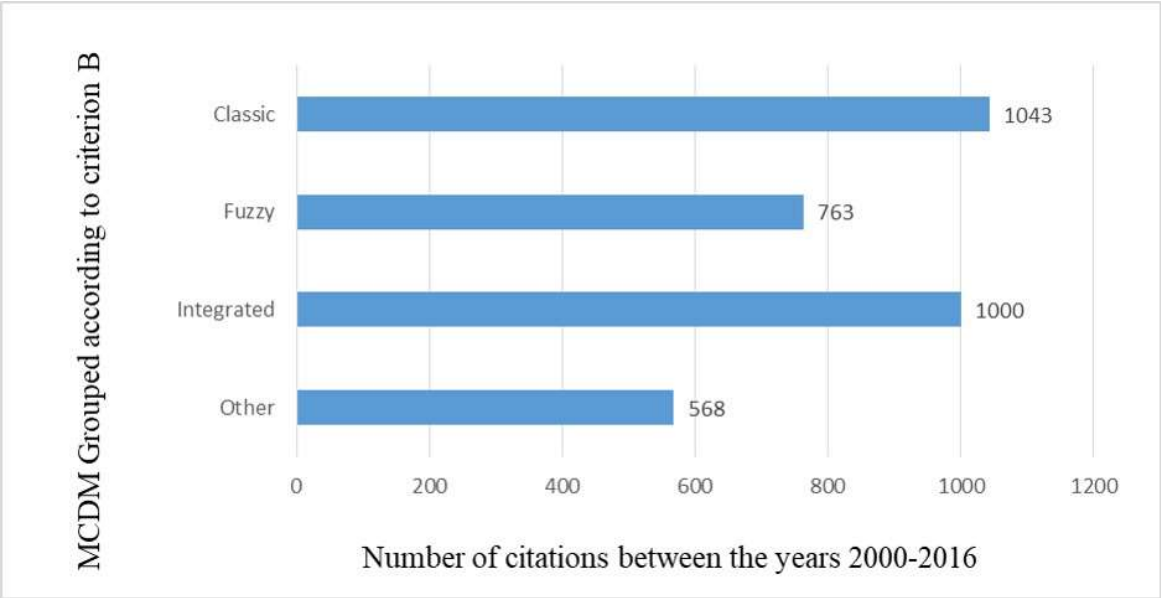

Figure 7. Publications cited between the years 2000-2016 (grouped according to criterion B)

Source: own elaboration.

One of the main factors which leads to the integration constraint, noted in the literature review, is the need for qualitative data processing and the converting of qualitative information to quantitative data. Such an example can be observed in the case of the GP method, which has no ability to handle qualitative data if it is not converted to quantitative form and another MCDM method is not used to perform this operation (Ramanathan & Ganesh, 1995). The results of the analysis can confirm this claim. Therefore, the GP method by itself has no publications describing an ERP system selection process research and case study. However, it is present in 10% of all cited publications as a participant in an integrated approach in this field of studies.

2.5 Conclusion

Multi-Criteria Decision Making methods possess the ability to consider and process multiple criteria and their weightings and therefore they have been widely used as a methodical instrument for the ERP system selection problem. The analysed literature reveals patterns of research and the application of different types of MCDM methods over the years.

These patterns can be used as a basis for further research and study of the different approaches for selecting the most appropriate ERP system for an organization.

Although research trends in this field can be analysed from different points of view, the analysis presented in this chapter shows the need for a combined, integrated method that assumes not only a strong, quantitative model, but can measure and reflect a qualitative input of information and data.

For example, a quantitative, mathematical MCDM method such as the GP method is not sufficiently adequate for handling a wide spectrum of qualitative information and data independently, which leads to the need for combination with other selection methods.

Another important point noted during the analysis of the different MCDM methods applied in the ERP system selection field is the popularity of the AHP approach along with its fuzzy extension and integrated applications as well as the large amount of unique MCDM methods suggested by various researchers and covered by many case studies. The analysis also revealed that a decreasing number of studies covered the application of MCDM methods to the ERP system selection process in the last few years. Nevertheless, no unified or agreed method was identified or accepted by the researchers or companies in industry.

The chapter reviewed the literature relevant to MCDM approaches used for selecting the most compatible system. The MCDM methods publications were compared and ranked according to their amount and the number of citations, which demonstrated their popularity and the tendencies in this research field. The analysis revealed a variety of methods, a spread of opinions and no accepted and agreed approach. In order to reduce this gap, further research should be performed in the direction of developing a complete, comprehensive approach that will be widely accepted and used for resolving ERP system implementation difficulties.

3 Empirical research methodology

3.1 Introduction

Previous chapters focused on the history of ERP systems and described the theoretical background of their lifecycle models, success and failure factors as well as selection criteria. Systematic comparison between system selection MCDM methods was also introduced.

Accordingly, the review presented in previous chapters led to several observations:

1. ERP systems are popular and valuable information systems for medium and large enterprises which are characterized by complicated and expensive implementation projects.
2. ERP system projects are risky for the organization and have a high potential for failure.
3. Various critical factors that contribute to successful implementation are identified in the reviewed literature. There is no closed and agreed list of factors.
4. Selection of the best system for an organization is identified as one of the most influential factors on the success or failure of the implementation process.
5. The selection process for the best-in-class ERP system is a multi-criteria problem that is often solved via the use of different MCDM methods.
6. The MCDM methods use weighted criteria for the selection process. There is no closed and agreed list of criteria, criteria grouping or weightings thereof.
7. The comparative analysis of the applications of MCDM methods on the ERP system selection process shows a wide dispersal of used methods. The most commonly mentioned MCDM methods are the AHP method, combined methods and methods with fuzzy extensions.

Following these observations, taking into consideration the importance of the selection process and the amount of criteria influencing the quality of that process, as well as the literature review findings that show inconsistency in dealing with selection process problems,

the next chapter will describe the goals and motivation for the research, the methodology used in this research to accomplish these goals and the reasons for selecting this method.

3.2 Motivation and goals

The covered literature points to the need for comprehensive research to identify the aspects that are significant to the success of an ERP selection process leading to a successful implementation project. The contribution of such research can be significant from both the academic and business point of view. The goal of the research is to uncover and examine the link between different elements of the selection process and its successful outcome. One of the elements the research intends to discuss in detail is the differences and resemblance in selection criteria weighting patterns for different groups and research populations. Some of the factors identified in the review will not be discussed in detail in the research and it will focus rather on the selection process due to the preliminary stage it represents in the lifecycle models and its primary importance. In other words, the selection process plays a crucial role in the successful result of a project. Although many other factors gain high rankings in the reviewed literature and are definitely important to the success of a project, the disastrous results of a misfit between the organization and the selected ERP system should not be underestimated. Some of the other factors will not have a chance to be fully expressed nor leave their mark on the project if the selected system is not suited to the organization in various parameters and leads to the failure of the project from its very beginning.

3.3 Research design

3.3.1 Research type

The current study intends to collect data from relevant respondents by the means of a questionnaire and can be categorized as descriptive research of the *Ex post facto* type, with the purpose of revealing the linkage between different criteria and other variables as well as the various classifications of the participants. The aim of this applied research is to find an explanation and as a result suggest a relatively usable solution for the problem of ERP system selection.

3.3.2 Research method

Driven by relevant theories and the reviewed literature, this deductive research presents hypotheses that will lead and guide the data collection process and its analysis using quantitative tools and statistical techniques (Rajagopal, 2002).

3.3.3 Research approaches

The qualitative hypotheses will be validated with the respondents' opinions and experience and will be measured using a quantitative, inferential approach and scales followed by empirical testing applying statistical test tools (Venkatesh, Brown, & Bala, 2013).

3.3.4 Significance of the research

The uniqueness of this study lies in the possibility of presenting an additional point of view on the ways to make a successful decision when choosing an ERP system. It is the outcome of a thorough literature review, the conclusion of which implies that difficulties still remain in the ERP system implementation processes. The problem of the selection process, which can be treated as an initial factor of success or failure that affects all subsequent phases of the project, has a wide range of approaches suggested as solutions. The significance of this research is in suggesting a detailed pattern, based on the questionnaire results, which is intended to assist the decision making process and add knowledge and deepen understanding of the reasons for the successful or failed selection of an ERP system.

3.3.5 Basic research assumptions

The next paragraphs describe the conceptual structure of the research project including the problem statement, population covered in the research, means used in the research to obtain the data, as well as the methods for processing and analysing it. The approach in the present research is to use a questionnaire in order to collect information from the relevant population and test the hypotheses through its results. The research was conducted on the basis of several assumptions that have been made in this research design:

1. There is a gap in the knowledge characterized by inconsistent information and its interpretation regarding the factors contributing to a successful or failed ERP project and one of its roots is in the selection process.
2. The information that was collected and analysed in the literature review part of the research fails to present a detailed picture of the selection process components and their importance to the success or failure of an ERP project.
3. Collecting information from a global sample of respondents representing a wide spectrum of professions with influential roles in ERP projects and analysis of the data using statistical tools can contribute to reducing the gap and revealing essential points for solving the ERP system selection problem.

3.4 Research problem formulation

The problems the current research is addressing are the absence of a predefined pattern for the ERP system selection process and consideration of the importance of different factors in the decision making process in general and criteria rating specifically, including: consultants, application of decision making methodology, industry specificity, organizational size, organizational environment, roles of the decision makers in the organization and demographic uniqueness.

3.5 Research objectives and questions

Following the literature review, objectives were formulated to describe the issues to be covered by the research. These general objectives were transformed into a specific set of questions to be answered by means of survey analysis.

The current research's first objective was to estimate the differences in the characteristics of organizations determining the selection criteria ratings and their importance to the success of an ERP system selection process. Thus, the research attempted to answer the following set of questions:

1) What are the differences in the rating of the selection criteria and their importance to successful ERP system selection between industry types?
2) How does the rating of the selection criteria and their importance to successful ERP system selection differ according to the size of the organization?
3) What are the differences in the rating of the selection criteria and their importance to successful ERP system selection according to the geographical location of the organization?
4) What are the differences between various types of organizations in the rating of the selection criteria and their significance to successful ERP system selection?

The second objective of the present study was to evaluate the importance of decision making methodology and external consultants to the success of ERP system selection. In this case, the research attempted to answer the following set of questions:

5) What is the importance of the use of decision making methodology to successful selection?
6) What is the importance of the professionalism of the external consultant's services for the successful selection of an ERP system?

The third objective of the present study was to evaluate the importance of the organizational environment in the use of decision making methodology.

7) What is the importance of the organizational environment in the use of decision making methodology?

3.6 Research hypotheses

The following predictive statements, organized and formulated as this study's hypotheses, are the result of the literature review's conclusions and observations presented previously. These hypotheses were tested and examined later on in this research, using the method of statistically measuring the important differences between the independent and dependent variables (Carmines & Zeller, 1979). The hypotheses describe the research suggestion for phenomena in the ERP system selection process to be tested in order to determine its validity.

H1. The importance of selection criteria to successful ERP system selection varies according to the type of industry.

H2. The larger the size of the organization, the greater the importance of deciding on some of the ERP system criteria for successful ERP system selection.

H3. The rating of selection criteria and their importance to successful ERP system selection differs by organizational location.

H4. The importance of selection criteria to successful ERP system selection varies according to the type of organization.

H5. When decision making methodology is being used, the indicators for successful selection of an ERP system are higher.

H6. With the professionalism of external consultants, the indicators for successful selection of an ERP system are higher.

H7. The frequency of use of decision making methodology increases when there are such tendencies in the organizational environment.

The research models presented (Figures 13, 14 & 15) describe the flow of the research process of testing and analysing the research hypotheses.

Hypothesis H1 relates to the first objective of the study with successful selection and selection criteria as the dependent variables and industry type as the independent variable.

Hypothesis H2 relates to the first objective of the study with successful selection and selection criteria as the dependent variables and organizational size as the independent variable.

Hypothesis H3 relates to the first objective of the study with successful selection and selection criteria as the dependent variables and organizational location as the independent variable.

Hypothesis H4 relates to the first objective of the study with successful selection and selection criteria as the dependent variables and organizational type as the independent variable.

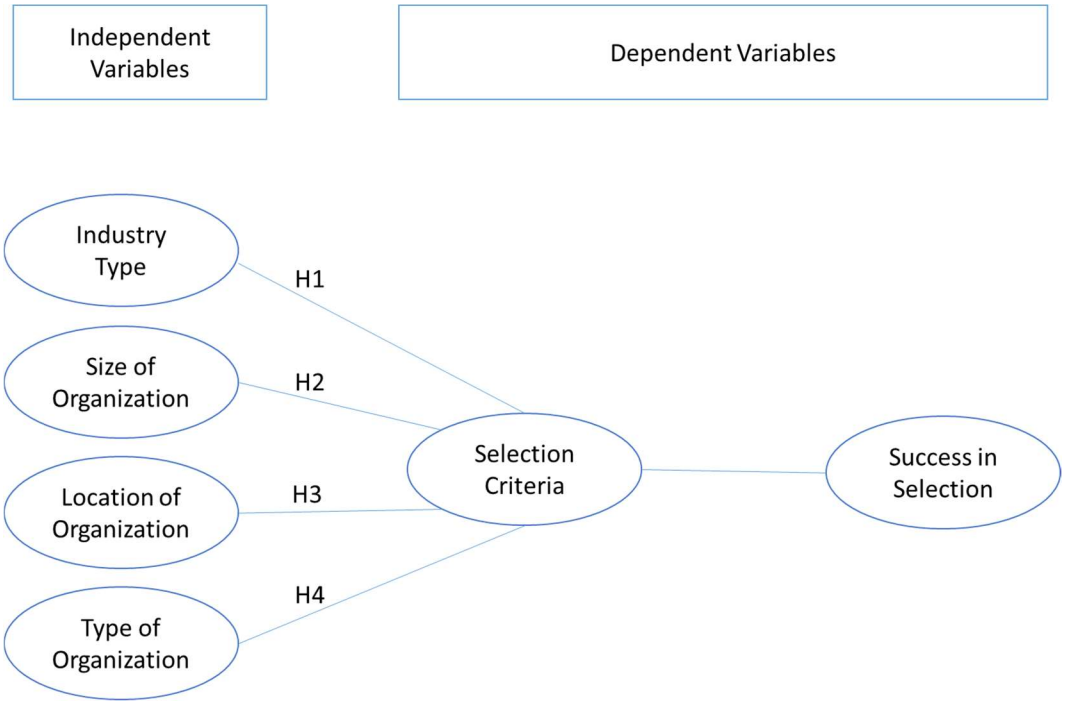

Figure 8. Research model relevant for hypotheses H1-H4

Source: own elaboration

Hypothesis H5 relates to the second objective of the study with successful selection as the dependent variable and the application of decision making methodology as the independent variable.

Hypothesis H6 relates to the second objective of the study with successful selection as the dependent variable and the use of professional external consultant services as the independent variable.

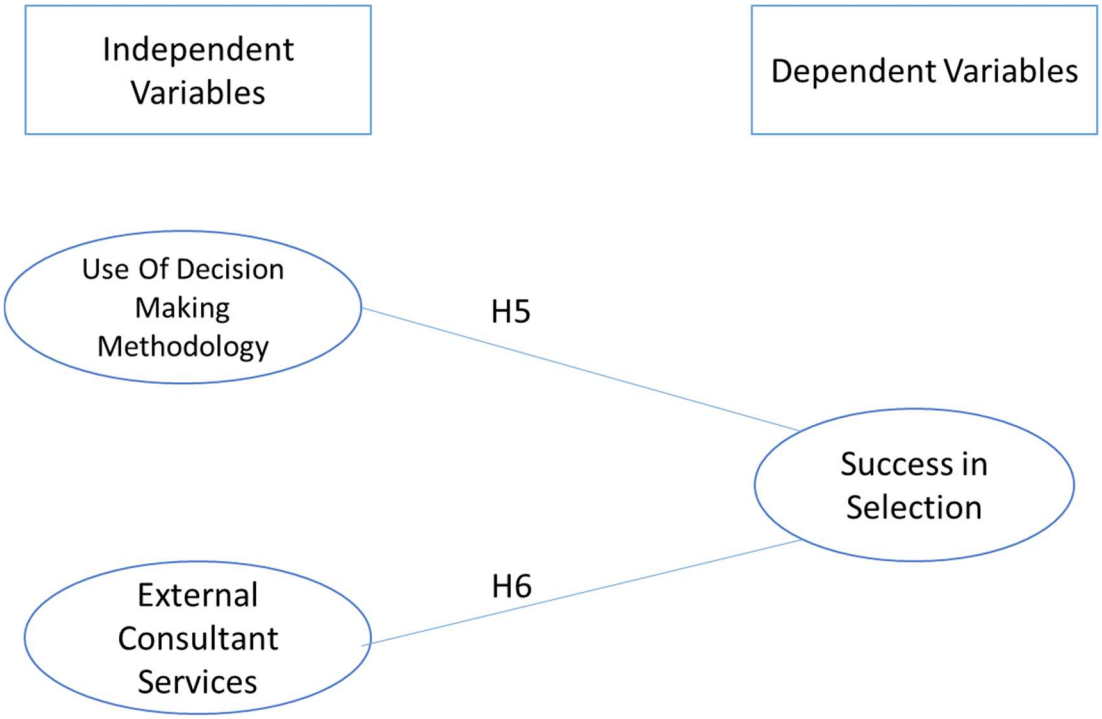

Figure 9. Research model relevant for hypotheses H5-H6

Source: own elaboration

Hypothesis H7 relates to the third objective of the study with the use of decision making methodology as the dependent variable and organizational environment characteristics as the independent variable.

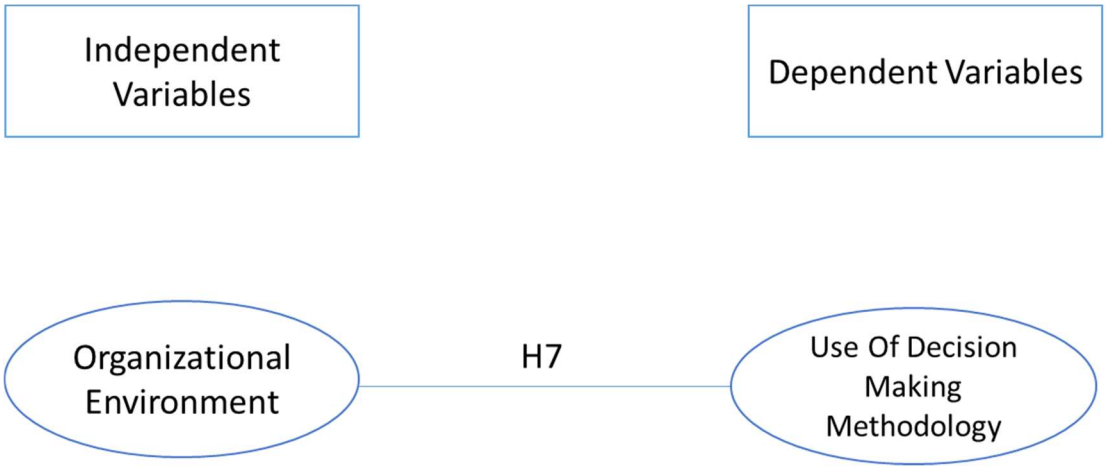

Figure 15. Research model relevant for hypothesis H7

Source: own elaboration

The variables used in the current research include independent variables and dependent variables. The dependent variables include the success of the selection process and the independent variables include the different characteristics of the organization and its environment such as the size of the organization, type of the organization, the use of decision making methodology and the professionalism of the used consultant services. Other dependent variables include the criteria ratings of importance to the success of the selection process and the use of decision making methodology (i.e. MCDM) during the selection process of an ERP system.

3.7 Procedures and techniques for data collection

One of the main issues raised in the literature review is the differences that occur in specifying and rating the criteria as well as partial information about the role of other aspects of the selection process. The method that was used in the present research to collect up to date information from the relevant population of professionals was a global survey. The questionnaire was conducted in order to add clarity to the information in this field of study and validate the hypotheses presented in this research. The survey goal is to provide statistical information about the target population. It is done by inferring the attributes which characterize the population according to answers provided by the sample respondents (Fowler, 2013).

Launched on the World Wide Web in 2003, the LinkedIn platform has become the leading social media network for businesses, professionals and scholars who reach out to connect and

collaborate with global or local colleagues. According to information from the LinkedIn site, as recorded on December 2017, it hosts more than 560 million users in over 200 countries and territories worldwide. At least 4 million professionals identify themselves on LinkedIn as directly related to the ERP systems content world in a wide range of roles and fields of interests. In addition, this platform provides a framework that enabled the survey to reach the desired exposure, with the relevant audience, while keeping to technical, budgetary and schedule constraints. Therefore, LinkedIn was selected as the preferred instrument for collecting and filtering the respondents, distributing the questionnaire and monitoring the responses retrieving process. The software used to graphically design and maintain the questionnaire and its user interface as well as to record the responses was the Surveymonkey.

Surveymonkey is popular, research oriented, web-based survey software, specializing in collecting responses from social media respondents. Surveymonkey was chosen due to its user friendly interface and structure, wide range of features, stable operational mechanism and the familiarity of many potential respondents with this tool due to its popularity (Gordon, 2002).

In the current research, a self-report type of questionnaire was used. It applied several response measuring techniques for quantifying data including closed-ended questions, Likert scale (Likert, 1932) questions and multiple choice questions (Krosnick & Wittenbrink, 2005). These techniques will be described later in this chapter.

3.8 Studied population definition

The current research sought to collect information from professionals and scholars who have an affinity with the ERP system content world in general and those who have opinions and points of view regarding the selection of an ERP system specifically. The sample of respondents consists of individuals who wished voluntarily to share their views and experiences by participating in the questionnaire.

3.9 Methods used in processing and analysing data (Measures)

3.9.1 Parts of the survey

In the current questionnaire (Appendix A), the respondents were asked to address the following according to the research objectives:

a) Introduction of the author, the subject, the questionnaire structure and the goal of the survey.

b) Questions regarding the respondent's opinion on ERP system selection process elements and their results.

c) Questions asking the respondents to rate different criteria according to their importance to the ERP system selection decision.

d) Demographic questions about the respondent's personal data and the organization relevant to his answers.

Responding to all sections and questions was mandatory. Thus, the respondent could not complete the survey unless all the questions were answered. The only other option for leaving the questionnaire was by abandoning the survey in progress. Participation in the questionnaire was anonymous and each participant who completed it had the ability to review a summary of results.

3.9.2 Survey Questions

The questions to be addressed in the current survey were based on the research questions and formulated in a way that would interest the respondent on the one hand and be simply phrased on the other. The short as possible questionnaire was designed in the knowledge that it was intended to be distributed via social media. Factors that could negatively influence the motivation to answer, or questions that could be ambiguous or misleading, were minimized. For example, there were no agree-disagree type questions included in the questionnaire due to respondents' tendency to agree with this type of question (Kuru & Pasek, 2016).

The list of questions appearing in the questionnaire is presented in table 4 and paired according to the group of relevance for further analysis.

Table 4. Survey questions.

No. of the question	Survey Question	Group of relevance
Q1	As part of your role in your organization, what stage during the ERP project you took an active part in? (More than one answer is possible)	Personal role of the respondent and characteristics
Q2	Were there several alternatives suggested during the selection stage?	Selection Alternatives
Q3	Was a Cloud based ERP system one of the alternatives considered?	Selection Alternatives
Q4	In your opinion, was the selection process of the ERP system professionally done?	Selection process
Q5	If an external consultant services were used during the selection process, in your opinion, was the recommendation submitted by him impartial?	External consultant
Q6	If external consultant services were used during the selection process, did the company accept the recommendation of the consultant?	External consultant
Q7	Was there a use of a Decision Making Methodology during the ERP selection process?	Use of Decision Making Methodology
Q8	How strongly your company's selection of an ERP system was influenced by its knowledge about the choice made by other firms in the industry (competitors, vendors, customers)?	Industry influence
Q9	From your point of view, was the selected system a good choice for the organization?	Success
Q10	How strong was the influence of the selection of the ERP system on the success or the failure of the implementation project?	Selection importance
Q11	On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.	The rating of the selection criteria

Q12	On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.	The rating of the selection criteria
Q13	On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.	The rating of the selection criteria
Q14	On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.	The rating of the selection criteria
Q15	What is the company decision making unit regarding ERP selection / headquarters location?	Organization size and characteristics
Q16	What was the location of your position during the ERP system selection process?	Personal role of the respondent and characteristics
Q17	What was your position during the ERP selection and implementation project?	Personal role of the respondent and characteristics
Q18	What is the size of the company you took part in an ERP Project for?	Organization size and characteristics
Q19	What is the type of the company you took part in an ERP Project for?	Organization size and characteristics
Q20	Which of the following best describes the principal industry of the organization you relate to in your answers?	Organization size and characteristics
Q21	What is your age?	Personal role of the respondent and characteristics

Source: own elaboration

3.9.3 Scales

The current questionnaire used several types of scales and measurement tools in order to provide a comfortable and convenient user experience, contributing to its completion rate and at the same time giving quantified data results for the qualitative questions being asked.

3.9.3.1 Closed-ended questions

In the conducted survey, closed-ended questions were used due to the difficulty of response collection for open-ended questions in a social-media based survey. The closed-ended questions are a time-efficient instrument both from the respondent time consumption perspective and from the perspective of relative simplicity in interpretation and analysis of collected data for research purposes (Cameron & James, 1987). For respondents who may have felt there was no exact match among the given answers to reflect their thoughts, an "Other, please specify" open text box was supplied for relevant questions.

3.9.3.2 Likert 5 point scale.

This originally ordinal type scale allows ranking and measuring of the strength of criteria from least to most influential. This type of measurement has no absolute values but permits comparison between the respondents' answers, where 1 is the least influential and 5 is the most influential. The scale was presented in two graphical standards, a graphic rating scale - floating selection between values 1-5 (questions Q8, Q10) and a numerical rating scale - selection of a specific value 1-5 (questions Q11-Q14). In question Q9 the value of 1 stands for "Bad choice" and the value of 5 stands for "Best choice" (graphical rating scale).

The selection of a Likert 5 point scale rather than a 7 point, 10 point or other standard was made after the literature review indicated that a 5 point standard leads to increased response rates and response quality, reducing frustration among respondents (Babakus & Mangold, 1992) and delivering higher reliability than other standards (Lissitz & Green, 1975). Being a popular standard, it also enables comparison with a wide range of other studies (Saleh & Ryan, 1991).

Other types of closed-ended question used were multiple choice questions with only one possible answer (questions Q2-Q7), multiple possible answers (question Q1), and demographic related questions with a single possible answer (questions Q15-Q21).

3.9.4 Statistical tools and techniques used for data analysis and validation

Nominal scale - used when the order of the values in the variable has no meaning and the goal is to label them and then identify them later on. For example, it can be a gender –

Male/Female or a number on a football player's shirt. No average calculation is made for this type of variable.

Ordinal scale - used when there is a meaning to the order of values in the variable but not to the intervals between them. An example is the case of age groups or organization size, using variable with values 1,2,3,4,5 where 1 is the smallest and 5 is the largest. The values themselves are artificial so the average age cannot be calculated because these are age groups.

Interval scale - used when both the order and the interval between the values have meaning. For example, when measuring a real age rather than an age group.

The type of measurement scale defines which statistical tools are used on each scale and the relationship between variables in different scales. In the current study, when using the Likert scale, the variable in the object should be recalculated from the Likert scale to a new scale that is not expressed in values 1,2,3,4,5 but rather as intermediate values due to the average calculation. It is equally possible to sum up the values and to receive an interval variable. If the Likert scale contains at least 5 values (or more), it is acceptable to refer to and perform analyses of an interval scale (Allen, 2007; Norman, 2010).

Pearson's correlation coefficient - examines the correlation between two variables on an interval scale. The test examines whether there is a covariance between two variables, regardless of the range of the scale. In this analysis, variables from different interval scales can be used.

The value obtained in the Pearson test is a standardized value between 0, -1 and +1. The higher the value, the stronger the relationship (mutual variation). Pearson is positive when the variables go in the same direction, for example, the older the child the bigger the shoe size. Pearson is negative when the variables go in the opposite direction e.g. the lower the temperature, the more energy is burned. The decision whether Pearson is significant or not depends, inter alia, on the strength of the dependence, but also on the size of the sample. Therefore, in the current study, Pearson's values were not very high, but still significant because the sample was relatively large (Hauke & Kossowski, 2011).

Spearman's rank correlation coefficient - a test similar to Pearson's test, with the difference lying in the type of measurement scale. This is a test that corresponds to variables

that have an Ordinal measurement scale. In this study, for example, this is the variable of the size of the organization and the age of the respondent. There is meaning to the order (from young to old, from small to large), but there is no significance to the value (1-5). The value does determine order but does not have numerical significance. Therefore, the formula used in this instrument is different from Pearson's test, but the interpretation of the findings is similar (Hauke & Kossowski, 2011).

t-test (Student's t-test) - for independent samples this is usually performed when the dependent variable is on an interval scale (the one for which an average is calculated) and the independent variable is nominal and consists of only two groups. In general, the analysis examines whether there is a significant difference in the mean score of the two groups. For example, is there a difference between organizations within and outside the EU and their definition of the level of success of the ERP system selection process? The test not only calculates the average, but also adds additional parameters to the formula such as standard deviation and group size. The number of value 't' has no meaning without significance. Once the value 't' is significant, the averages of the two groups are compared. If there is a significant difference, there is a gap between organizations within and outside the European Union in defining the level of success of the ERP system selection process, and if not, the gap is not significant (Singh, 2007).

One-way ANOVA analysis of variance - performed when the dependent variable is on an interval scale (with mean calculation) and the independent variable is on a nominal scale in more than 2 groups. For example, type of organization: for-profit organization, non-profit organization, government organization. The analysis in the first part examines whether there are differences in averages, as is the case in the t-test. If significance was found, the question arises as to its source (Stoline, 1981). For example, between a for-profit organization and a non-profit organization or between a for-profit organization and a government organization. In such cases, an additional follow-up test is carried out. In this study, a Scheffe test was performed focusing on the question of which groups the significant gap was found between (Shaffer, 1995). The statistical value is the F test, i.e. the assumption that the means are equal among the examined population, which is distributed normally and has the same standard deviation. Without significance, the number itself is meaningless.

Normal distribution - tests such as ANOVA and the t-test assume a normal distribution. Once the dependent variable has been tested on an Interval scale, there is a normal distribution assumption as is common in such studies. In this study, there was no reason to assume that there was a non-normal distribution. The sample consisted of more than 500 respondents. The dependent variable was measured on a 5-point scale and it was possible to calculate averages and statistics based on averages.

Chi-squared test - comparing frequencies using crosstabs, conducted in order to find a connection between two variables on a nominal scale, for example, type of organization: for-profit organization, non-profit organization, government organization and continent. The test checks whether the percentages in the cross are consistent or variable. If there is a percentage difference between the different cells, a significant chi-squared value is obtained (Singh, 2007).

MANOVA - a two way analysis that has one dependent variable on an interval scale and two independent variables on a nominal scale. The analysis examines whether there is interaction between the two independent variables in the dependent variable interpretation (French, Macedo, Poulsen, Waterson, & Yu, 2008). For example, the dependent variable is how successful the system is considered to be. The independent variable is the type of organization - for-profit, non-profit, government. Until this stage, a one-way analysis was examined, i.e. whether the success of the ERP system selection process was different according to the type of organization. At this stage, another independent variable can be added, for example, whether it is a European Union country or not. The aim of adding another independent variable is to examine whether affiliation to the EU is significant to the one-way relationship found by the type of organization. Assuming that in for-profit organizations we have a reported high success rate and a low level of success in government organizations, it can be shown that in European Union countries there is no difference between for-profit organizations and non-profit organizations and in non-EU countries the difference is so significant that it is responsible for the main effect on the phenomena found in the first stage of the analysis.

Interaction - is a concept that occurs under certain conditions in which an additional independent variable is added into a model and the main effect changes. The way to examine whether there is an interaction is to perform a MANOVA statistical test and to obtain the value

F, with which it is possible to determine the significance of the interaction. In this study there was no significant interaction.

Regression - with regard to the regression question in this study, it should be noted that in some analyses there were high degrees of freedom, which could have affected the significance and generally harm the ability to draw statistical conclusions. Therefore, some of the independent variables with too many values were reduced. However, there is still a large amount of values in some variables such as countries and industries. A regression test, if intended, requires a different structure and a higher number of respondents. When the independent variable is measured on an interval scale it is added as one variable and this is considered to be one degree of freedom. Therefore, if there are independent variables with multiple values on a nominal scale, many dichotomous sub-variables of yes / no answers are required. Accordingly, it is not statistically likely that 500 respondents will allow a large enough sample to perform a regression test with all the independent multi-value variables (Massy, 1965; Osborne & Waters, 2002; Raviv, 2006).

Descriptive statistics - deals with the processing of raw data, its systematization, visual presentation in the form of charts, graphs and tables, as well as their quantitative description by means of basic statistical tools and techniques partially described previously. Calculations used in the descriptive statistics, as part of the data processing, are applied on both dependent and independent variables for values retrieved from the sample and resulting in calculated values such as average, mean standard deviation, frequencies etc. (Hinton, 2014).

3.9.5 Research questions and the related measures in the questionnaire

The research questions were paired with a set of relevant questions in the questionnaire (Table 5) in order to define statistically important differences between them and to test the hypotheses.

Table 5. Research and survey questions paired.

First Objective

No.	Research Questions	Survey Question No. Key
1.	What are the differences in the ratings of the selection criteria and their importance to successful ERP system selection between industry types?	Q9,Q11,Q12, Q13, Q14,Q20
2.	How does the rating of the selection criteria and their importance to successful ERP system selection differ by the size of the organization?	Q9,Q11,Q12, Q13, Q14,Q18
3.	What are the differences in the ratings of the selection criteria and their importance to successful ERP system selection according to the geographical location of the organization?	Q9,Q11,Q12, Q13, Q14, Q15
4.	What are the differences between various types of organizations in the ratings of the selection criteria and their significance to successful ERP system selection?	Q7,Q9,Q11,Q12, Q13,Q14, Q18,Q19,Q20

Second Objective

No.	Research Questions	Survey Question No. Key
5.	What is the importance of the use of decision making methodology for successful selection?	Q7,Q9
6.	What is the importance of the professionalism of the external consultant's services for the successful selection of an ERP system?	Q5,Q6,Q9

Third Objective

No.	Research Questions	Survey Question No. Key
7.	What is the importance of the organizational environment in the use of decision making methodology?	Q1,Q5,Q6,Q7,Q8, Q9,Q11,Q12,Q13, Q14, Q15,Q17, Q20

Source: own elaboration

3.10 Data Collection

As stated in previous chapters, one of the recurring issues regarding the use of criteria for prioritization during the ERP system selection process is the high volume of different lists and groupings of criteria found in the literature. The current study intended to build a closed group of criteria deduced from the reviewed studies in order to create common ground for further prioritization and comparison between the different criteria. Therefore, as a preliminary phase of the research, this study presents a self-elaborated categorization and grouping process of the selection criteria based on the literature review.

The categorization was made following the next stages of data processing:

1. Identifying the criteria mentioned (Second level criteria) in the literature review.
2. Identifying unique general groups (Top level criteria) from the literature review.
3. Identifying and generalizing criteria to unique groups.
4. Deductive reduction of the similar criteria.

Stage no.1

In the process of the literature review, 192 second level criteria were identified and listed with reference to their origin (Appendix B).

Stage no.2

The general, top level groups were identified (Table 6) from the literature review by extracting the first or top level criteria in various studies (Teltumbde, 2000), (Ünal & Güner, 2009), (Olson, Johansson, & de Carvalho, 2012), (López & Ishizaka, 2017) and more.

Table 6. The identified top level groups

No.	Top level criteria	Description
1	Cost	The term Cost is used to describe second level criteria relating to the cost of the system and licenses, implementation costs, total cost of the project, etc.
2	Technology	The term Technology is used to describe second level criteria relating to security, reliability, flexibility, compatibility, ease of use of the ERP system and more.
3	Functionality	The term Functionality is used to describe second level criteria relating to the ability of the ERP system to support different organizational processes and needs.
4	Time	The term Time is used to describe the consumption of time and the length of processes such as: implementation period, training period, etc.
5	Market	The term Market is used to describe the ERP system market including second level criteria such as: Consumer preferences, Market share, Vendor's reputation, Vision.
6	Quality	The term Quality is used to describe second level criteria such as: service quality, training quality, support quality.
7	Multilingual system	The term Multilingual system is used to describe the system’s ability to support the various linguistic needs of different countries and territories including the needs of multinational organizations.

Source: own elaboration

Stage no. 3

During this stage, the second level criteria were classified into top level criteria according to their verbal meaning, key words and logical essence. Later, the logical duplicates were removed by using the fuzzy-lookup tool.

The fuzzy lookup tool, developed by the Microsoft Corporation as an add-on for Microsoft Excel software, enables data cleaning and reclamation. The feature of the tool that was used in the current stage was the ability to compare mass data and retrieve similarity reports between the various data in numeric value which indicates the level of similarity on a scale from 0 to 1, where 1 stands for full similarity, or in other words identity. The comparison performed by the fuzzy lookup tool is based on examining direct textual similarity and non-direct textual similarity using customizations that include transformation capturing in cases of syntactical differences that still share the same meaning and therefore logical similarity (Arasu et al., 2011).

As a result of the described data cleaning process, the total amount of second level criteria was reduced to 158 second level criteria and classified into a relevant top level criterion.

Stage no. 4

The 158 second level criteria were again processed with the use of the fuzzy lookup tool, this time with a lower degree of similarity, limited to an internal list of each top level criterion. Afterwards, these criteria were manually processed and as a result classified into a general second level criterion in order to minimize repetitive cases. The manual processing was done by using sorting questions (Table 7) which helped to identify the significance of each second level criterion to the relevant top level criterion.

These questions, used as sort of a “litmus test” in this process, implied binary ‘Yes’ or ‘No’ answers:

Table 7. Criteria sorting questions.

No.	Top Level Criteria	Question
1	Cost	Does it measure a specific cost component? Price tag? Amount?
2	Time	Does it have an influence on the time schedule of the project?
3	Functionality	Does it have a specific function component?
4	Technology	Does it have a specific technological component?
5	Market	Is it a subject of market position comparison between competitors?
6	Quality	Does it measure and compare quality?
7	Multilingual system	Is it relevant to the language support given by the system?

Source: own elaboration

Eventually, the classification process defined a final set of 20 unique second level criteria that were sorted into 7 unique top level criteria (Table 6).

After completing the described preliminary stages, questionnaire design and format, the survey was prepared for distribution to potential respondents.

The purpose of the sampling process in a quantitative study is to draw a representative sample from the population in order to generalize the results of the research back to the population (Marshall, 1996). To achieve this aim, a *Random sample* technique of an *Expert sampling* type was used in the current research combined with *Snowball sampling* (Singh, 2007).

For applying this type of sample technique, a list of relevant experience, expertise and skills in this research field of study was generated based on the literature review. This list defined the relevant group of professionals to be addressed as the potential sample population. The majority of the sample within this expert population was picked by using a random sampling technique. Thus, almost all persons in the population had equal chances to be selected assuming that the research characteristics are normally distributed within the population of the experts and as a result produce a representative sample (Marshall, 1996). In addition, the

snowball sampling technique was used in order to provide a lead for an additional set of respondents who are less reachable or difficult to receive responses from without a personal recommendation from an acquaintance (Singh, 2007). A similar approach is often used in this field of study to collect relevant references due to its complex and very specific nature, which can only be obtained from a group of professionals. Some examples of studies using similar techniques are: Amberg et.al., (2008); Silva et.al., (2013); Bharathi & Mandal, (2015).

As mentioned previously, the social media selected to be the platform for the current survey distribution was LinkedIn. Groups, forums and individuals can be searched in LinkedIn by their subject of interest and their involvement with a professional field of work or study. The target audience was defined by its relevance to ERP system projects as described earlier. Using the LinkedIn internal search engine, a total of 4,443 global, worldwide located users were identified as the relevant target audience. Before distributing the invitation via social media, a pilot survey was conducted using an audience of 14 Israeli ERP system specialists who answered the survey and sent their remarks. After reviewing the remarks, the survey was distributed via LinkedIn to the rest of the target population.

These 4,443 LinkedIn users received the following invitation to take part in the survey by clicking the hyperlink and by this action being transferred to the survey page at the surveymonkey.com service server.

"Hello {name}, hope you are doing well!

I would like to invite you to participate in a short, 5-minute academic survey I'm conducting. It refers to the ERP system selection process and it is completely anonymous and you can leave it at any point. Your input and professional insights will be highly appreciated. The results of the survey will be accessible after you complete it. https://www.surveymonkey.com/r/ERPselectionsurvey. Please let me know if you have any questions.

Thank you in advance,

Ilya Birfer"

The surveymonkey.com service supports access to the survey from different kinds of devices, including PC's, notebooks, tablets, and smartphones. Various operating systems and internet browsers are also supported in order to maximize the amount of respondents who can participate using the type of technology they possess.

Technical information regarding the survey:

- The pilot survey was conducted between 15 February 2018 and 01 March 2018.
- The main survey was conducted between 01 March 2018 and 08 August 2018.
- Average completion rate, meaning the average percentage of respondents who completed the survey was 83%. Typical time spent, meaning the median amount of time respondents spent answering the survey, was 6 minutes and 46 seconds.

3.11 Participant characteristics

The survey sample consists of 510 valid responses from the international group of individuals who participated in the survey. Due to missing data caused by the abandonment of the survey form at an early stage, 56 potential responses were not included in the analysis. The sample size of the current survey can be comparable to other surveys performed in this field of study, such as Gable, Sedera, & Chan (2003), featuring a sample size of 310 responses, and Sedera (2008) with a 319 sample size.

Table 8. Questionnaire response rate.

	N	**%**
Questionnaires invitation sent	4,457	100
Questionnaires received	566	13
Valid responses collected	510	11
Rejected responses	56	1
Non-responses	3,891	87

Source: own elaboration

The relatively low rate of received questionnaires in comparison to the amount of sent invitations to participate, as shown in Table 8, can be explained by the tool used to contact and send the invitation. In this case, the LinkedIn social media platform on the one hand offers accessibility and exposure to a high number of relevant, potential respondents, but on the other hand it is less personal and binding in terms of answering such an invitation.

The respondents who held, at the time of the survey or in the past, various roles in the implementation projects of ERP systems are shown in Table 9. In this question (Q1), respondents were asked about the nature of their duties, since some respondents were responsible for more than one role. The table demonstrates the sample's distribution by roles.

Table 9. Roles and stages in the ERP project the respondents took an active part in – Survey question number 1 (Q1).

	N	%
Implementation of the ERP system	288	56,5
Use and maintenance of the ERP system	208	40,8
Selection of ERP software, vendor and implementation partner	194	38,0
Company's definition of a business vision regarding ERP system	178	34,9
ERP system evaluation	172	33,7
ERP system retirement	80	15,7
All of the stages above	143	28,0
None of the above	29	5,7

Source: own elaboration

As shown in Table 9 and Chart 1, 56.5% of the respondents were involved in the implementation of an ERP system in an organization; 40.8% mentioned that they used and maintained the system; 38.0% were involved in selecting the software, the vendor and the implementation partner; 34.9% dealt with the definition of the business goals with respect to the ERP system; and 33.7% dealt with the ERP system retirement phase. In addition, 28% of the respondents reported that they were involved in all roles related to the ERP system, while 5.7% were not involved in any of the roles mentioned.

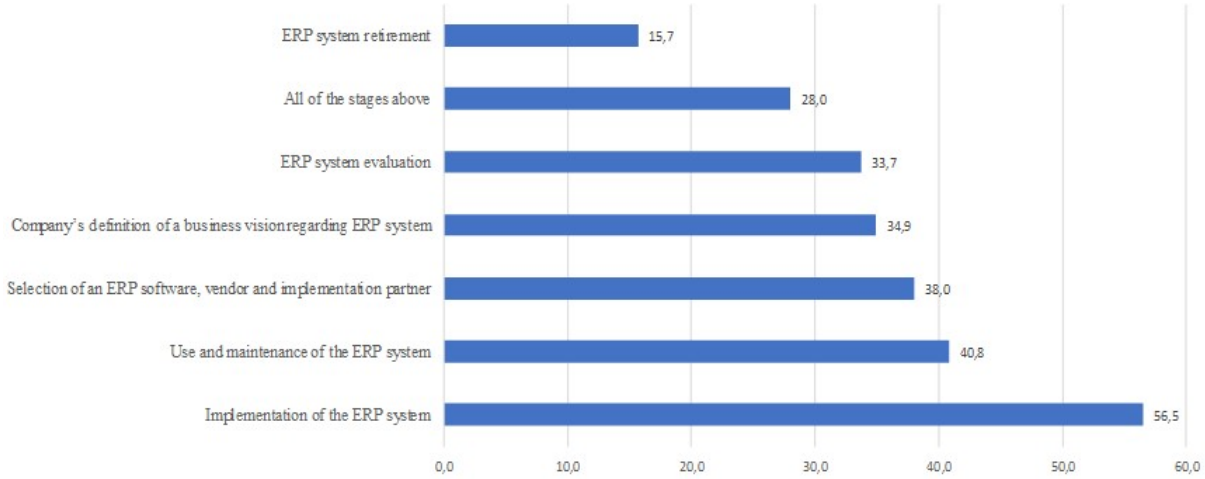

Chart 1. Roles and stages in the ERP project the respondents took an active part in

Source: own elaboration

The respondents were classified, according to their answer to question 21, into age ranges as shown in Table 10 and Chart 2, where the majority of the respondents, 60.8%, were 30 to 49 years old and 33.5% were in the middle age range between the ages of 50 and 64. Only 5.7% were under the age of 30 or over the age of 65.

Table 10. Age range classification of the sample - Q21.

	N	**%**
18 to 29	17	4,0
30 to 49	256	60,8
50 to 64	141	33,5
65 years and over	7	1,7
Total	**421**	**100,0**

Source: own elaboration

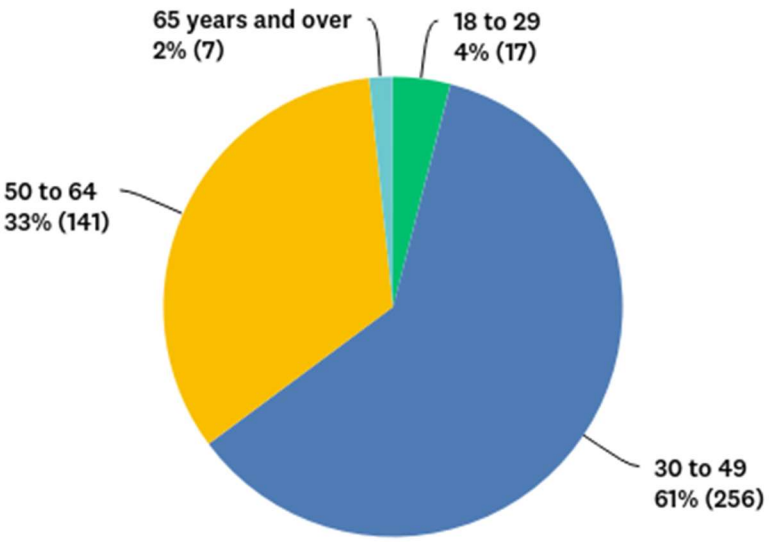

Chart 2. Age range classification of the sample

Source: own elaboration

As shown in Table 11 and Chart 3, almost two-thirds of the respondents were in three positions: Chief Information Officer (21.4%), project manager (21.1%) and business analyst/functional consultant (20.9%).

Table 11. Position during the ERP selection and implementation project - Q17.

	N	**%**
CIO	90	21,4
Project Manager	89	21,1
Business analyst/Functional consultant	88	20,9
ERP Team Manager	48	11,4
External ERP Selection Consultant	28	6,7
CTO	12	2,9
CFO	7	1,7
CEO	7	1,7
Other	52	12,4
Total	**421**	**100,0**

Source: own elaboration

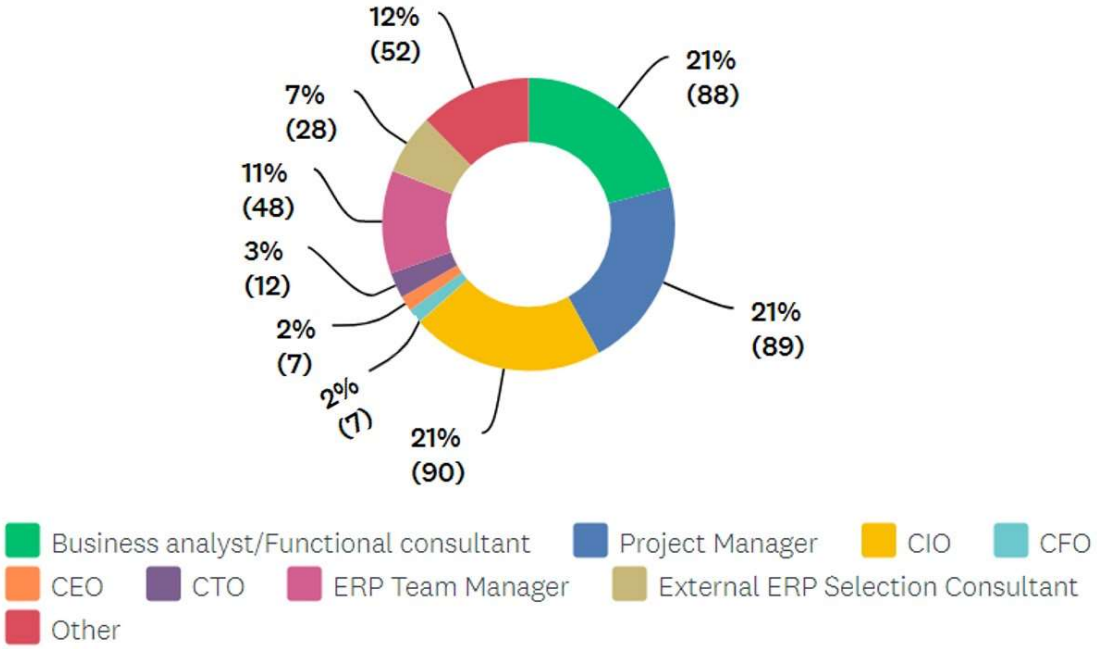

Chart 3. Position during the ERP selection and implementation project

Source: own elaboration

Additional collected data that contribute to describing the respondents is presented and analysed in detail in the next chapter.

3.12 Conclusion

In the current chapter, the research methodology as well as research approaches and design were described, and the hypotheses to be tested were defined and explained. The self-reporting type questionnaire used in the survey and the internal validation of its design, structure and questions were covered in detail. The statistical techniques to be used in order to externally validate the responses retrieved in the performed survey were also described. The survey participants' characteristics revealed the population in detail as well as the survey acceptance rate among the potential sample. The next chapter will deal with the collected results, their analysis and interpretation.

4 Evaluation of elements of the ERP system selection process as factors for the success of ERP system implementation – analysis and results

4.1 Introduction

The results retrieved from the survey were analysed using different statistical instruments. Alpha Cronbach analysis was used to check and confirm the reliability of the different variables. Pearson's correlation coefficient, Spearman's rank correlation coefficient, t-test, One-way ANOVA analysis of variance, Chi-squared and MANOVA, all assuming normal distribution, were used to test the hypotheses.

Descriptive statistics in the current research deal with the processing of raw data, its systematization, visual presentation in the form of charts, graphs and tables, as well as its explanatory and quantitative description, by means of basic statistical tools and techniques partially described previously. Calculations used in the descriptive statistics, as part of the data processing, were applied on both dependent and independent variables for values retrieved from the sample and resulting in calculated values such as average, mean standard deviation, frequencies etc. The inferential statistics, in turn, deal with the estimation of population parameters and testing of hypotheses using statistical instruments such as correlation tests.

4.2 Descriptive statistics review of the survey results

4.2.1 Reliability analysis of selection criteria ratings and their importance to the successful selection of an ERP system.

The dependent variable consisted of a set of 20 second level criteria and for each, the respondents were asked to rate to what extent the criterion affected the success of the ERP system selection process. The rating was on a 5-point scale from lack of influence to a very strong effect; the higher the rating, the stronger the effect of the criterion. The different criteria cover 7 top level criteria: Cost, Technology, Functionality, Time, Market, Quality, and Multilingual System. In order to examine the degree of consistency in the respondents' responses to the various criteria, Cronbach's alpha reliability coefficient was calculated for each dimension, as shown in Table 12.

Table 12. Alpha Cronbach analysis of the rating of the selection criteria and their impact on successful ERP system selection.

Variables/Top level criteria	Second level criteria	Alpha
Cost	Total cost	0.46
	ROI (Return of Investment)	
Technology	Relevance of technology	0.83
	Compatibility with third party	
	Reliability	
	Security	
	Configuration approach	
	Simplicity of technology	
	Service and support	
	Technical requirements and performance	
Functionality	Functional capability	0.71
	Functional fit and flexibility	
Time	Time of full implementation	0.69
	Training time	
Market	System general reputation	0.74
	Systems vendor future vision and strategy	
	System reputation industry specific	
Quality	Quality of implementation	0.83
	Quality of training and support	
Multilingual system	Multilingual system	--

Source: own elaboration

In the Cronbach analysis of the various criteria, moderate to high reliability coefficients were found, as detailed in Table 12 above, indicating consistency in the responses of the subjects to the criteria that comprise that factor. However, in the functional dimension, it was found that the multilingual system criterion is not consistent with the factor and was therefore examined separately.

4.3 Variables

4.3.1 Descriptive statistics for the dependent variables

The respondents' ratings of the degree of influence of the various criteria are presented in the following Table 13.

Table 13. Averages of the selection criteria ratings and their impact on successful ERP system selection.

Selection criteria	Min.	Max.	Mean	SD
Cost	1	5	3,8	,78
Technology	1	5	3,9	,60
Functionality	1	5	4,3	,66
Time	1	5	3,5	,80
Market	1	5	3,9	,72
Quality	1	5	3,9	,81
Multilingual system	1	5	3,2	1,22

Source: own elaboration

According to the respondents' ratings, the ERP functionality dimension is the criterion that is perceived to have the greatest impact on the decision making process (mean 4.3), whereas the dimensions of the multilingual system (mean 3.2) and time (mean 3.5) are perceived as the least influential.

In an attempt to assure the relevance of the submitted data and to optimize the results, respondents with 0 range between the Min. and Max. in their answers were omitted from the additional analysis (Table 13.1). The intention of this activity was to check whether the respondent had any variance in his answers or did not have any opinion regarding the differences in the influence of each one of the criteria. The reasons for identical rating of all the criteria could be negligence during the process or no opinion regarding the differences between the criteria. Thus, 74 respondents found with 0 range were removed from the analysis and the results were reprocessed and presented whenever a significant difference from the general group of results was found.

Table 13.1. Average rate of the selection criteria ratings and their impact on successful ERP system selection after 74 zero range responses were removed.

Selection criteria	Min.	Max.	Mean	SD
Cost	1,0	5,0	3,8	,79
Technology	1,4	5,0	3,9	,58
Functionality	1,0	5,0	4,3	,64
Time	1,5	5,0	3,5	,78
Market	1,0	5,0	3,9	,70
Quality	1,0	5,0	3,9	,80
Multilingual system	1,0	5,0	3,2	1,22

Source: own elaboration

As to whether a decision making methodology was used in the system selection process, 59.2% reported using such a methodology, 19.4% did not use any methodology and 15.1% did not know (Table 14, Chart 4). In the later analyses, the respondents who did not know or replied that this was irrelevant were omitted from the analysis.

Table 14. Use of a decision making methodology during the ERP selection process - Q7.

	N	%
There was use of a decision making methodology for the selection	302	59,2
There was no use of a decision making methodology for the selection	99	19,4
Don't know	77	15,1
Not relevant	32	6,3
Total	**510**	**100,0**

Source: own elaboration

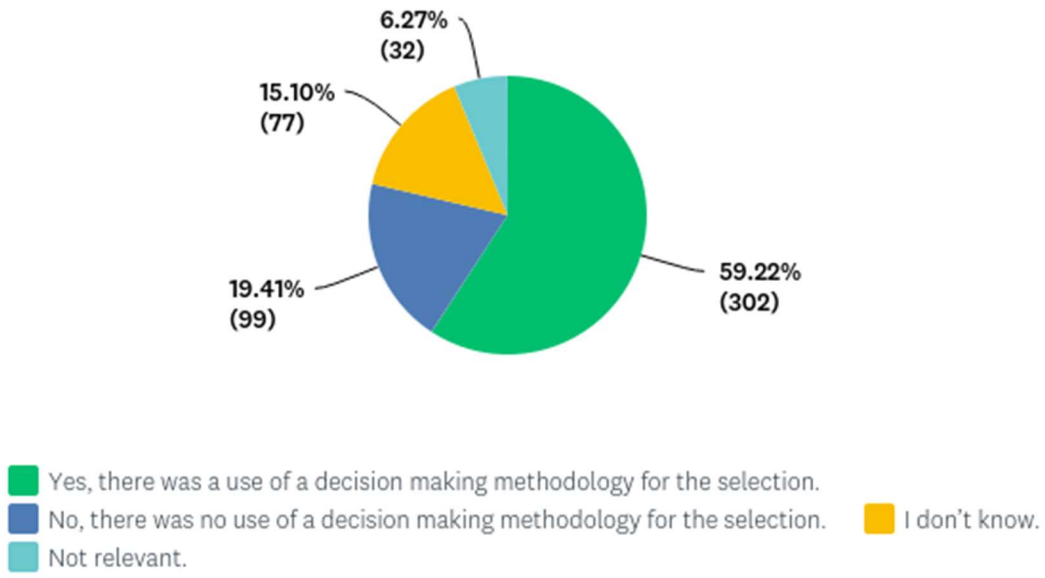

Chart 4. Use of a decision making methodology during the ERP selection process

Source: own elaboration

Respondents were asked to assess whether, in their opinion, the system ultimately selected was a good choice for the organization. The rating is made on a 5-point scale, with a low rating (minimum 1) indicating a bad choice, while a high rating (maximum 5) indicates the best choice. The number of valid respondents was 469, i.e. 41 did not answer the question. Only 3.4% thought the selected system was a bad choice for the organization, 35.4% thought it was a reasonable choice for the system, and the majority of 61.2% thought the system selected was the best possible choice for the organization (Table 15). The average rating was 3.9 (standard deviation 0.95) which means that the average rating was medium-high.

Table 15. Evaluation of the result of the selection - Q9

	N	**%**
Bad choice	16	3.4
Reasonable choice	166	35.4
Best choice	287	61.2
Total	**469**	**100,0**

Source: own elaboration

Respondents were asked to assess the extent to which the process of selecting an ERP system for the organization affected the success or failure in implementing the project. The rating was made on a 5-point scale, with a low rating (minimum 1) indicating no effect and a high rating (maximum 5) indicating a strong effect. The number of valid respondents was 469,

i.e. 41 did not answer the question. Only 9.2% reported that there was no impact, 32.4% reported that it had a certain influence, while 58.5% said it had a strong influence (Table 16). The average rating was 3.7 (standard deviation 1.10), which means that the average rating was medium-high.

Table 16. The level of influence of the selection of the ERP system on the success of the implementation process – Q10.

	N	%
No influence	43	9.2
Some influence	152	32,4
Strong influence	274	58,5
Total	469	100,0

4.3.2 Descriptive statistics for the independent variables

Question 20 in the questionnaire examined what kind of industry the organization belongs to. A total of 27 categories of industries were presented to the respondents, as well as an "Other" category. Based on the responses received in the “Other” category, two additional categories were added, making a total of 29 types of industries. In order to reduce the number of categories of the industry type variable, a category grouping was introduced and 10 types of industries, together with the “Other” category, (Table 17, Chart 5) were obtained that combine the 29 types of industries from the original variable (Appendix C presents the industry type grouping).

Table 17. Distribution of respondents by industry type.

Type of Industry	**N**	**%**
Manufacturing	126	33,5
Information Technology	49	13
Professional Services	44	11,7
Healthcare	37	9,8
Construction	27	7,2
Retail & Distribution	24	6,4
Finance, Insurance & Realty	17	4,5
Telecommunications	15	4
Non-profit	13	3,5
Education	8	2,1
Other	16	4,3
Total	**376**	**100,0**

Source: own elaboration

The distribution of types of industries is presented from the most common to the least common. The table shows that one-third of the respondents represent manufacturing industry, 13% information technology industry, 11.7% professional services industry, 9.8% healthcare industry, while the rest of the industry sectors are low frequency. In the later analyses, the respondents who did not know or replied "Other" were omitted from the analysis.

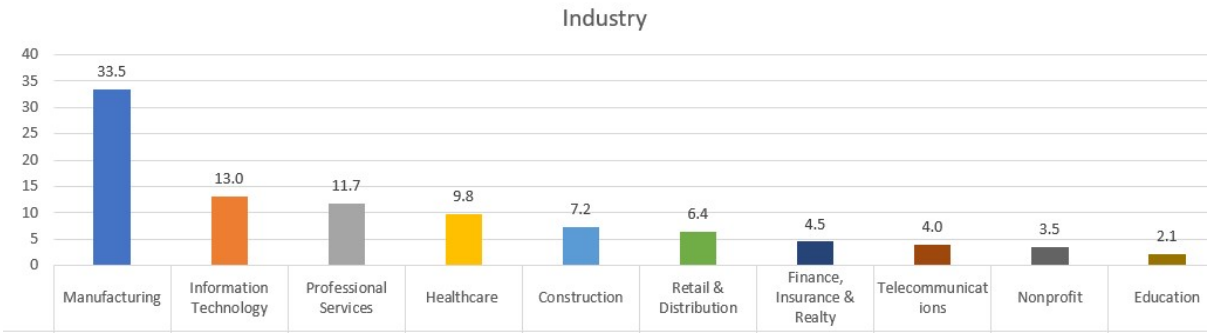

Chart 5. Distribution of respondents by industry type

Source: own elaboration

Table 18 and Chart 6 describe the size of the organization in which the ERP project was implemented. The size of the organizations is measured by the number of employees. About one third of the organizations employ 1,001 to 10,000 employees, and 26.1% employ between 201 and 1,000 employees. Fewer respondents were operating in small organizations with up to 200 employees (18.1%) and large organizations with over 10,000 employees (13.8%) and over 50,000 employees (8.6%). In the later analyses, the respondents who did not know or replied that this was irrelevant were omitted from the analysis.

Table 18. Distribution of respondents by organizational size –Q18.

Number of Employees	**N**	**%**
1-200 employees	76	18,1
201-1,000 employees	110	26,1
1,001-10,000 employees	141	33,5
10,001-50,000 employees	58	13,8
50,001+employees	36	8,6
Total	**421**	**100,0**

Source: own elaboration

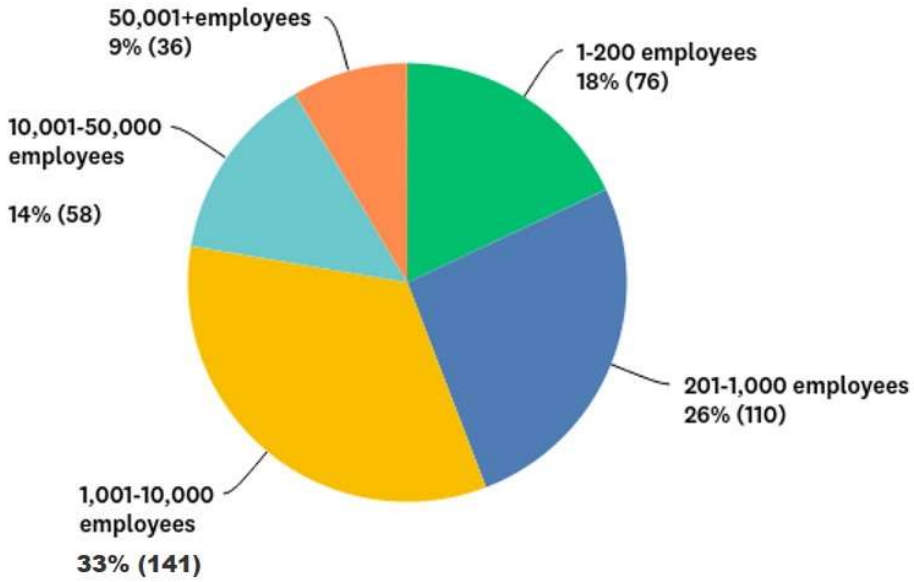

Chart 6. Distribution of respondents by organizational size

Source: own elaboration

Questions 15 and 16 checked the location of the company's activity: Question 15 relates to the geographical location of the organization's head office, while Question 16 refers to the geographical location of the participants who answered the questionnaire. Respondents noted the name of the country in which the company's management is active. A number of classifications were made in order to reduce categories for subsequent analysis. More than two-thirds of the respondents reported that they were working in the same country as the organization's management, while about a third of them were in another country than the management base (Table 19, Chart 7).

Table 19. The distribution of respondents from countries with more than 10 respondents in the study, compared with other countries.

Country Name	Headquarters location		The location of your position	
	N	%	N	%
US - United States	85	16,7	65	12,7
IN - India	32	6,3	36	7,1
GB - United Kingdom	30	5,9	32	6,3
DE - Germany	28	5,5	16	3,1
AU - Australia	26	5,1	26	5,1
BR - Brazil	26	5,1	29	5,7
IL - Israel	19	3,7	19	3,7
PL - Poland	17	3,3	25	4,9
FR - France	14	2,7	13	2,5
CA - Canada	12	2,4	12	2,4
GR - Greece	10	2	11	2,2
IT - Italy	10	2	10	2
Other	201	39,4	216	42,4
Total	**510**	**100**	**510**	**100**

Source: own elaboration

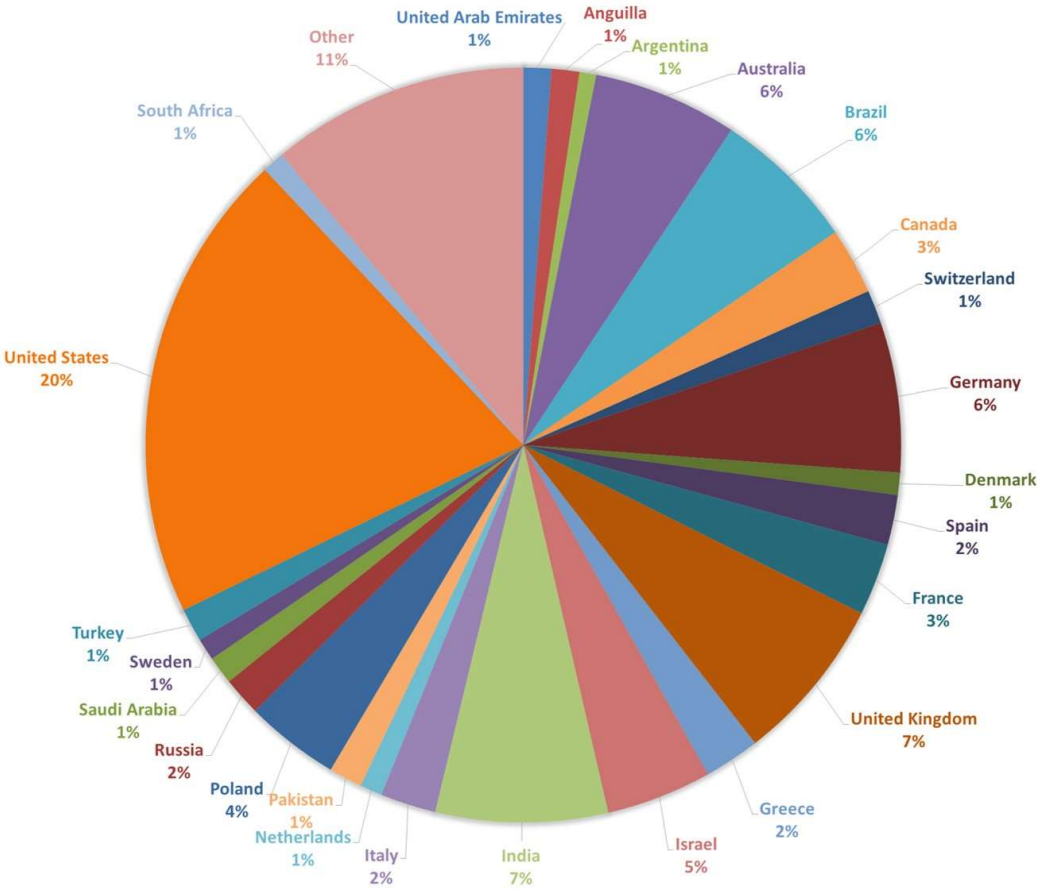

Chart 7. Headquarters location distribution

* The following countries where the percentage of participants was less than 1% are shown in the chart as "Other": Andorra , Albania, Armenia, Austria, Belgium, Chile, Czech Republic, Georgia, Croatia, Hungary, Ireland, Iran, Japan, Kuwait, Kazakhstan, Lithuania, Morocco, Mauritius, Mexico, Malaysia, Norway, New Zealand, Portugal, Palau, Qatar, Serbia, Singapore, Swaziland, Taiwan, Ukraine, Vietnam

Source: own elaboration

The leading countries according to the number of respondents are presented in Table 17 in the order from highest to lowest (only 10 or more respondents). The United States leads by a large margin, followed by India, Britain, Germany, Australia, Brazil, Israel, Poland and others. The full list of countries represented by the respondents was grouped by several criteria such as European Union membership, continent and other classifications detailed in Appendix D. The distribution of respondents by grouping is presented in Tables 20, 21, and 22.

Table 20. Distribution of respondents according to countries that are members of the European Union compared to other countries.

Group name	Headquarters location		The location of your position	
	N	%	N	%
European Union countries	143	28	144	28,2
Other countries	367	72	366	71,8
Total	**510**	**100**	**510**	**100**
	Headquarters location		**The location of your position**	
European Union countries	143	87,2	144	86,7
European countries but not in the European Union	21	12,8	22	13,3
Total	**164**	**100,0**	**166**	**100,0**

Source: own elaboration

Of all the respondents, 28% work in organizations operating in the EU. Comparing EU countries and non-EU member countries (N = 164, N = 166), 87% are active in EU countries, compared to only 13% in non-EU European countries.

Table 21. Distribution of respondents according to countries in the former USSR compared to other countries.

Group name	Headquarters location		The location of your position	
	N	**%**	**N**	**%**
Former USSR	13	2,5	12	2,4
Others	497	97,5	498	97,6
Total	**510**	**100**	**510**	**100**

Source: own elaboration

As shown in Table 21, 2.5% of respondents are from the former Soviet Union.

Table 22. Distribution of respondents by continent (N = 419).

Group name	Headquarters location		The location of your position	
	N	**%**	**N**	**%**
Europe	165	39,4	169	40,3
North America	103	24,6	83	19,8
South America	31	7,4	35	8,4
Asia	85	20,3	97	23,2
Africa	7	1,7	8	1,9
Oceania	28	6,7	27	6,4
Total	**419**	**100**	**419**	**100**

Source: own elaboration

The leading continents in terms of quantity of respondents are Europe (about 40%), North America and Asia (around 20% each).

Most of the organizations included in the study are for-profit business entities (81.7%), along with a small number of non-profit organizations (3.8%) or government organizations (8.8%). Some 5.7% of the respondents replied "Other", meaning the organization was not one of the three types of organization mentioned above (Table 23). In the later analyses, the respondents who did not know or replied “Other” were omitted from the analysis.

Table 23. Distribution of respondents by the type of organization.

Organization Type	**N**	**%**
Other (please specify)	24	5,7
For-Profit Corporation	344	81,7
Non-Profit Organization	16	3,8
Government Organization	37	8,8
Total	**421**	**100,0**

Source: own elaboration

About half of the respondents (46.9%) reported that they chose from between three or more ERP systems, about a quarter chose between two systems, 14.5% indicated that they had no choice but a single system, while 14.5% claimed that the question was irrelevant to them (Table 24, Chart 8). In the later analyses, the respondents who claimed that the question was not relevant were omitted from the analysis.

Table 24. The number of alternatives suggested during the selection stage – Q2.

	N	%
No alternative ERP systems were suggested.	74	14,5
The selection was between 2 different ERP systems.	123	24,1
The selection was between 3 or more different ERP systems.	239	46,9
Not relevant.	74	14,5
Total	**510**	**100,0**

Source: own elaboration

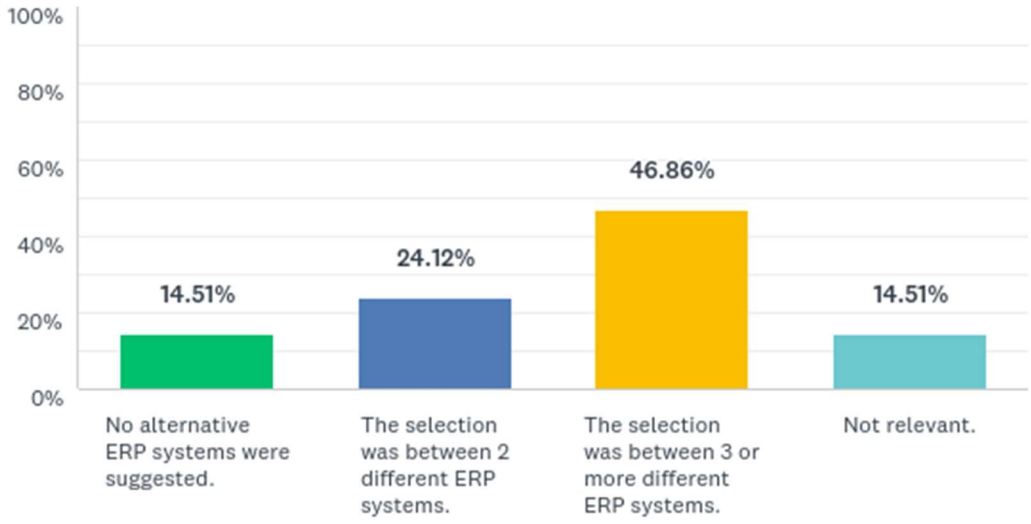

Chart 8. The number of alternatives suggested during the selection stage

Source: own elaboration

On the question of whether one of the options considered during the selection process was a cloud-based ERP system, 52.7% reported that among the alternatives presented to them was at least one or more cloud-based systems, 34.7% said there was no such system, 12.5% did not know or stated that it was not relevant (Table 25, Chart 9). In the later analyses, the respondents who did not know or replied that this was irrelevant were omitted from the analysis.

Table 25. Cloud based ERP systems were suggested as one of the alternatives - Q3.

	N	%
Yes, one or more of the alternatives was a cloud based ERP system	269	52,7
No, all the alternatives were on-premises ERP systems	177	34,7
I don't know	23	4,5
Not relevant	41	8,0
Total	**510**	**100,0**

Source: own elaboration

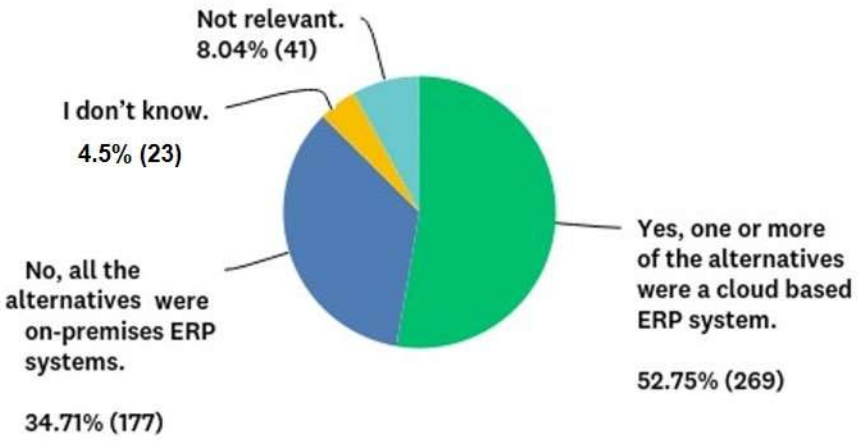

Chart 9. Cloud based ERP system was suggested as one of the alternatives

Source: own elaboration

Respondents were asked to assess whether the selection process of the ERP system was carried out professionally. Some 60.4% reported that in their opinion the process was professional, compared with 19.6% who stated that it was done with partial professionalism. Another 2.4% claimed that the process was unprofessional, and 8% found it difficult to estimate. Similarly, 8.6% claimed they did not know or that the question was irrelevant (Table 26, Chart 10). In the later analyses, the respondents who did not know or replied that this was irrelevant were omitted from the analysis.

Table 26. The professionalism of the selection process of the ERP system – Q4.

	N	%
Professionally done	308	60,4
Not professionally done	12	2,4
Partially professionally done	100	19,6
It is hard to tell	41	8,0
Don't know	30	5,9
Not relevant	19	3,7
Total	**510**	**100,0**

Source: own elaboration

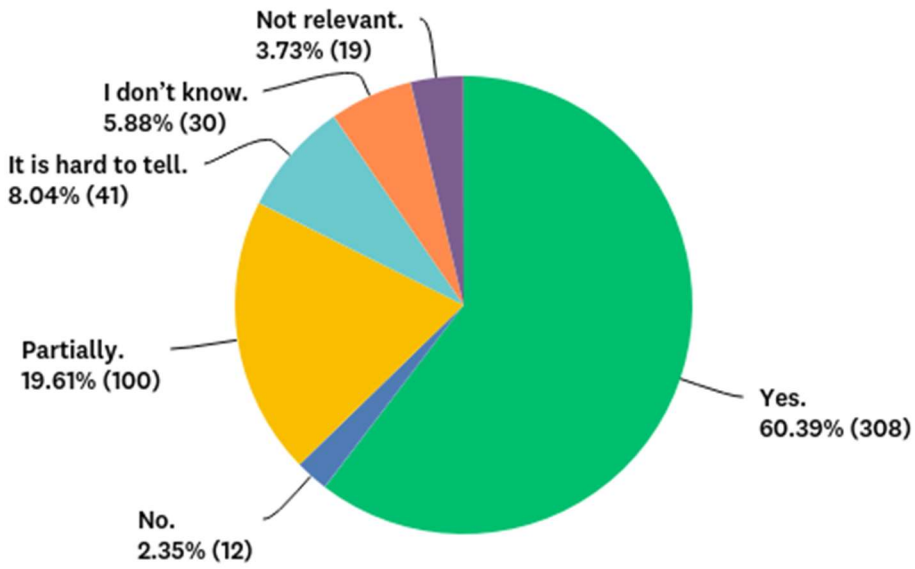

Chart 10. The professionalism of the selection process of the ERP system

Source: own elaboration

The respondents were asked to assess whether the organization hired external consulting in the selection process of the ERP system and if so, in their opinion, were the consultant's recommendations made without bias? Some 29.2% confirmed that the advisor's recommendations were given impartially, while 13.9% thought the process was biased, and 11.4% did not express a firm position. Another 24.7% reported that their organization was not assisted by an external consultant in the process (Table 27, Chart 11). In the later analyses, the respondents who did not know or replied that this was irrelevant were omitted from the analysis.

Table 27. Objectivity of the external consultant's recommendations – Q5.

	N	%
Yes, the recommendation was impartial	149	29,2
No, the results were biased	71	13,9
It is hard to tell	58	11,4
Don't know	47	9,2
No external consultant was used during the selection process	126	24,7
Not relevant	59	11,6
Total	**510**	**100,0**

Source: own elaboration

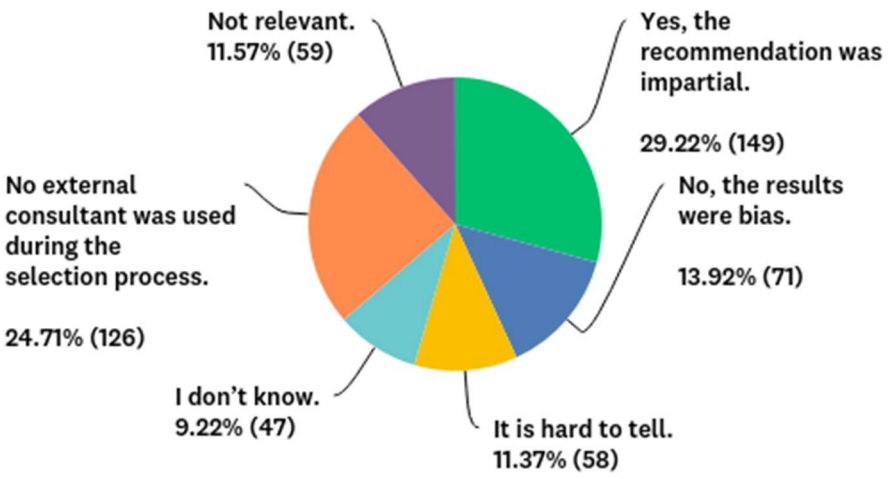

Chart 11. Objectivity of the external consultant's recommendations

Source: own elaboration

Respondents were asked whether, in the event that the organization used external consultation in the decision making process, the company accepted the recommendations of the external consultant. Some 29.2% noted that the question was not relevant, as apparently the organization they represented did not hire an external consultant, and another 10% said they did not know. Therefore, these two groups were not included in the follow-up analysis. Only 1.8% reported that the organization completely rejected the recommendations of the external consultant, compared to 23.3% who fully adopted the recommendations, 24.1% who

adopted them partially, and another 11.6% who applied for a second opinion (Table 28, Chart 12).

Table 28. Acceptance of the consultant's recommendations – Q6.

	N	%
Yes, the recommendations were fully accepted	119	23,3
No, the recommendations were fully rejected	9	1,8
The recommendations were partially accepted	123	24,1
The company asked for a second opinion before deciding	59	11,6
I don't know	51	10,0
Not relevant	149	29,2
Total	**510**	**100,0**

Source: own elaboration

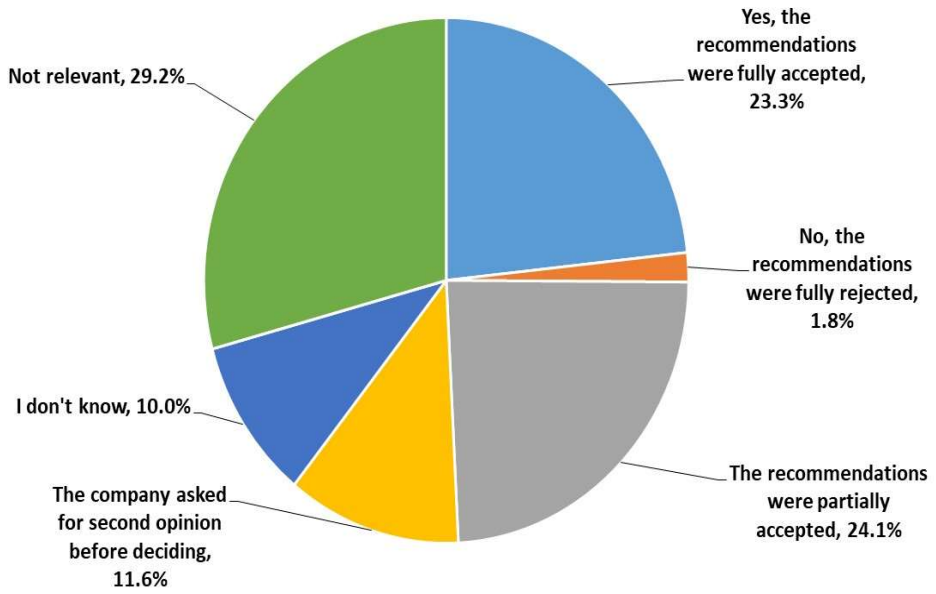

Chart 12. Acceptance of the consultant's recommendations

Source: own elaboration

The participants were asked to assess the extent to which the ERP system selection process was influenced by prior knowledge about the choices of other industry organizations, such as

competitors, vendors, or customers. The rating was made on a 5-point scale, with a low rating (minimum 1) indicating no effect and a high rating (maximum 5) indicating a strong effect. The number of valid respondents was 469, i.e. 41 did not answer the question. Only 13.6% reported that there was no effect, 42.0% reported that it had some effect, while 44.3% said it had a strong effect (Table 29). The average rating was 3.4 (standard deviation 1.10), which means that the rating was medium or higher.

Table 29. Influence of other firms in the industry on selection – Q8.

	N	**%**
No influence	64	13,6
Some influence	197	42
Strong influence	208	44,3
Total	**469**	**100,0**

Source: own elaboration

4.4 The first objective of the analysis

The first objective of the present study is to estimate the differences in the characteristics of organizations determining the selection criteria ratings and their importance to the success of an ERP system selection process.

The following variables were examined as relevant to the first objective, using the following set of questions:

- Question 9: From your point of view, was the selected system a good choice for the organization?
- Questions 11-14: What were the ratings of the selection criteria and their impact on successful ERP system selection?
- Question 15: What is the company's decision making unit regarding ERP selection / headquarters location?
- Question 16: What was the location of your position during the ERP system selection process?
- Question 18: What is the size of the company you took part in an ERP Project for?
- Question 19: What is the type of the company you took part in an ERP Project for?

The description of the variables is detailed in the section on descriptive statistics.

In order to examine whether there is a correlation between the dependent variables, a Pearson correlation test was performed, as shown in Table 30.

Table 30. Pearson coefficient between dependent variables.

The ratings of the selection criteria and their impact on successful ERP system selection	**The system was a good choice for the organization**
Cost	,016
Technology	,297**
Functionality	,276**
Time	,034
Market	,250**
Quality	,175**
Multilingual	,056

(**) p<0.01

Source: own elaboration

There are significant positive correlations between 4 of the 7 criteria and the respondents' perception of success. The four criteria found to be influencing the perception of success are: Technology r=.30; p<.01, Functionality r=.28; p<.01, Market r=.25; p<.01, Quality r=.18; p<.01. In other words, the greater the weight the organization gives to technology, functionality, market, and quality in the decision making process, the greater the chances of successful ERP system selection. In contrast, cost, time and multi-language dimensions were not found to have a significant impact on the success of the ERP system selection process.

4.4.1 Hypothesis-testing of H1-H4.

4.4.1.1 H1. The importance of selection criteria to successful ERP system selection varies according to the type of industry.

The hypothesis examined whether the ratings of the various criteria and the perception of successful ERP system selection differ by industry type. The independent variable is the type of industry, whereas the dependent variables are the respondents' perception of the effect of different criteria on the decision on the chosen system, and the respondent's perception of

whether the chosen system was the best choice for the organization (question 9). The hypothesis was analysed using one-way ANOVA analysis of the dependent variables, comparing the ratings of the respondents in each of the 10 industries.

The findings indicate a lack of importance of industry type in the respondents' ratings. The test of variability is not significant. Therefore, this research hypothesis was not supported.

Additional analysis was carried out to test the connection between successful selection and the industry's influence on the organization. The analysis examined whether there was a correlation between the extent to which information from other organizations in the industry affected the decision making (question 8) and the success of the selection process (question 9). It was tested using the Pearson correlation coefficient and a significant positive correlation was found $r=0.14$; $p<.01$.

Further analysis examined whether the type of industry and the ratings of the various criteria were a factor in the decision regarding the ERP system. In this analysis, the "small" industries represented by less than 20 respondents were omitted - Telecommunications, Education, Finance, Insurance & Realty, Non-profit, after ensuring that they did not contribute to variance in the dependent variable. The hypothesis was examined using a one-way ANOVA analysis.

The results showed that there are no significant differences between the industry and the various criteria, i.e. there are no differences between the various industries in respondents' perceptions of which criteria are more important in the decision regarding the ERP system. However, correlation was found between the extent to which information from other organizations in the industry affected the decision making and the success of the selection process.

4.4.1.2 H2. The larger the size of the organization, the greater the importance of deciding on some of the ERP system criteria for successful ERP system selection.

The hypothesis examined whether the ratings of the various criteria differ by the size of the organization and whether this is important to the perception of successful ERP system selection. The independent variable is the size of the organization (question 18). The dependent variables are the respondent's perception of the effect of different criteria on the

decision on the chosen system, and the employee's perception of whether the chosen system was the best choice for the organization (question 9).

The hypothesis was examined using two types of analysis: the Spearman test and one-way ANOVA analysis. The Spearman test examined whether there is a linear correlation between the size of the organization and respondents' perceptions of the decision making process for selecting an ERP system. This analysis was chosen because the independent variable, the size of the organization, was on an ordinal scale (Table 31). ANOVA analysis analysed whether there is a difference in the ratings of the decision making process for selecting an ERP system according to the size of the organization, assuming that the relationship is not necessarily linear.

Table 31. Spearman coefficient between the size of the organization and the respondents' perception of the decision making process for selecting the ERP system.

	Company size
The selected system was a good choice for the organization	,025
The influence on the ratings of the selection criteria:	
Cost	,075
Technology	,094
Functionality	,147**
Time	,051
Market	,133**
Quality	,04
Multilingual	,219**

(**) p<0.01

Source: own elaboration

There were significant positive correlations between the size of the organization and the respondents' perception of the effect of the following three criteria on the decision making process for selecting an ERP system for the organization: Functionality r = 0.14; p <.01, Market r = 0.13; p <.01 Multilingual r = 0.22; p < .01. No significant correlations were found for the

criteria of cost, technology, time and quality which are not related to the size of the organization.

As shown in Table 32, there are significant differences according to the size of the organization in the following dimensions: technology, functionality, market, and multilingual. In this analysis the organizations were re-grouped into 3 sizes: a small organization (1-1,000 employees), a medium organization (1,001-10,000 employees), and a large organization (over 10,000 employees). The hypothesis was examined using one-way ANOVA analysis. The differences are reflected in the disparities between small and mid-size organizations, with the latter giving higher ratings.

Table 32. Ratings of the various criteria that were a factor in deciding on an ERP system according to the size of the organization.

	Organization size							
	1-1000		**1001-10000**		**10001+**			
Criteria	**M**	**SD**	**M**	**SD**	**M**	**SD**	**F**	**sig.**
Cost	3.8	0.75	3.9	0.69	3.8	0.93	0.99	0.372
Technology	3.8	0.62	4.0	0.53	4.0	0.61	3.05*	0.049
Functionality	4.2	0.70	4.4	0.61	4.4	0.62	5.69**	0.004
Time	3.5	0.81	3.5	0.70	3.7	0.86	2.19	0.113
Market	3.8	0.68	4.0	0.70	4.0	0.66	7.53**	0.001
Quality	3.9	0.87	4.0	0.74	4.0	0.75	1.77	0.172
Multilingual	2.9	1.18	3.3	1.19	3.6	1.26	12.27**	0.000

(**) p<.01; (*) p<.05

Source: own elaboration

At the same time, no association was found between the size of the organization and the respondents' reports as to whether the chosen system was good for the organization (r = 0.03ns). As mentioned above, the hypothesis was examined using additional analysis, ANOVA variance analysis. The findings are presented in Table 33.

Table 33. The participants' perception of the decision making process for choosing an ERP system according to the size of the organization.

	Company size											
	1-200		**201-1,000**		**1,001-10,000**		**10,001-50,000**		**50,001+**			
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**F(4,416)**	**sig.**
The selected system was a good choice for the organization	3,9	0,91	3,8	0,98	4.0	0,86	4,0	0,93	3,6	1,02	1,48	0,209
The influence on the rating of the selection criteria:												
Cost	3,8	0,79	3,7	0,72	3,9	0,69	3,8	0,87	3,9	1,03	,527	,716
Technology	3,9	0,66	3,8	0,59	4,0	0,53	3,9	0,61	4,0	0,61	1,832	,122
Functionality	4,2	0,79	4,2	0,63	4,4	0,61	4,5	0,56	4,4	0,71	2,923*	,021
Time	3,6	0,83	3,4	0,79	3,5	0,70	3,8	0,79	3,5	0,95	2,345	,054
Market	$3,9^{2}$	0,68	$3,6^{1}$	0,66	$4,0^{2}$	0,70	$4,1^{2}$	0,64	$4,0^{2}$	0,70	6,544**	,000
Quality	4,0	0,86	3,7	0,85	4,0	0,74	4,1	0,71	4,0	0,81	2,373	,052
Multilingual	3,0	1,23	$2,8^{1}$	1,14	$3,3^{2}$	1,19	$3,5^{2}$	1,25	$3,8^{2}$	1,27	6,933**	,000

Notes: (F) – F-values; (Sig.) – level of significance (**) p<.01; (SD) - standard deviation; (M) – means; – the mean values are accompanied by superscripts 1, 2 – they signify that value 2 is statistically the highest and 1 is significantly the lowest, at α=0.05 level of significance.

Source: own elaboration

The ANOVA variance test examines whether the average ratings of the criteria vary at different levels of organization size, assuming that there may be nonlinear differences between organizations. Similar to the Spearman test, this analysis also found significant differences in organizational size according to the three criteria mentioned above: functionality, market and multi-language. In order to know the source of the statistical significance, a Scheffe follow-up test was performed as shown in Table 33 (by superscripts 1, 2), and the difference between them is responsible for the statistical significance. In general, the findings of the analysis of the variance are consistent with the trend that was shown in the Spearman analysis, according to which the relationship between the size of the organization and the criteria rating is linear, thus, the larger the organization, the greater the importance of deciding on the ERP system according to the criteria of system functionality, market and multi-language.

An additional test was performed in order to analyse the effect of different industry types in conjunction with the organization size on the ratings of the selection criteria.

In this case, a general linear model, two-way MANOVA, was used for the dependent variable (criterion) with two independent variables (organizational size, industry type). Interaction analysis examines whether the ratings of the various criteria depend on the type of industry and whether they differ by the size of the organization. The results show that the values of the variance in the F test that examined the interaction of the size of the organization and the type of industry on the different criteria are not significant in all 7 examined criteria. This means that there is no dependence on the size of the organization and the type of industry.

In conclusion, it can be concluded that the research hypothesis was partially supported. In relation to three dimensions - functionality, market, and multi-language the hypothesis was supported, whereas in the other dimensions the hypothesis was not supported.

4.4.1.3 H3. The rating of selection criteria and their importance to successful ERP system selection differs by organizational location.

As described in the descriptive statistics section, the variable of geographical area examined in two questions (questions 15 and 16) on the basis of the organization's management, was characterized by several divisions, such as belonging to a continent, the European Union vs. non-EU member states, leading countries with a relatively high number of respondents in the current sample and more. The examination of the geographical region's importance to the dependent variables was done using two different types of analysis - a t-test with an independent variable of 2 groups and a one-way ANOVA test where the independent variable includes 3 groups or more. To make a comparison between EU countries and other countries (Table 34), in order to examine whether there are differences between organizations in EU countries compared with other countries, a t-test was performed on the dependent variables.

Table 34. The ratings of the selection criteria and their impact on the success of ERP system selection, according to the geographical base of the organization. EU vs Non-EU.

	Geographical base of the organization					
	European Union		**Others**			
	M	SD	M	SD	t	Sig.
Cost	3,7	0,76	3,8	0,79	-1,36	0,174

Technology	3,8	0,57	4,0	0,61	-3,17**	0,002
Functionality	4,2	0,64	4,3	0,67	-1,47	0,143
Time	3,4	0,73	3,6	0,81	-3,20**	0,001
Market	3,7	0,66	4,0	0,73	-3,23**	0,001
Quality	3,8	0,83	4,0	0,80	-2,00*	0,046
Multilingual	3,3	1,15	3,1	1,25	0,90	0,367

(**) p<.01 ; (*) p<.05

Source: own elaboration

In four of the seven dimensions, there were significant differences between organizations in the EU countries compared with organizations in other countries, as detailed below: technology t = -3.17; p <.01, time t = -3.2; p <.01, market t = -3.2; p <.01, quality t = -201; p <.05. No significant differences in the ratings for the cost, functionality and multilingualism criteria were found.

The findings of the analysis based on the geographical location of the respondent are similar (Table 35) to those obtained in the analysis based on organizational location.

Table 35. The ratings of the selection criteria and their impact on the success of an ERP system selection process, according to the geographical position of the respondent.

	Geographical position of the respondent					
Top level criteria	**European Union**		**Others**			
	M	SD	M	SD	t	Sig.
Cost	3,8	0,78	3,8	0,78	-1,01	0,314
Technology	3,7	0,59	4,0	0,60	-4,00**	0.000
Functionality	4,3	0,68	4,3	0,65	-1,20	0,229
Time	3,4	0,74	3,6	0,81	-3,20**	0,001
Market	3,7	0,72	4,0	0,71	-3,11**	0,002
Quality	3,8	0,85	4,0	0,79	-2,05*	0,041
Multilingual	3,2	1,17	3,2	1,24	0,47	0,638

(**) p<.01; (*) p<.05

Source: own elaboration

The results of the comparison of EU countries with non-EU European countries showed, in t-test analysis, no significant differences. Additional comparison by continent (North America and South America separately) was made between 6 continents: Europe, North America, South America, Asia, Africa and Oceania, using a one-way ANOVA test.

As demonstrated in Table 36, there are significant differences by continent in four of the seven dimensions, as detailed: Technology t = 4.96; p <.01: This criterion received a higher rating than any of the others for companies from Africa (4.3) and the lowest for European companies (3.7). Market t = 5.75; P <.01: in South America (4.3) and Africa (4.2), the ratings were the highest, while Europe had the lowest average ratings (3.7). Quality t = 2.28; p <.05: this criterion received the highest rating in the African continent (4.4) and the lowest in European companies (3.8). Multilingual t = 3.64; p <.01: this criterion received higher ratings on the continents of Europe, America and Asia (3.2-3.3), and significantly lower on the continent of Oceania (2.3).

Table 36. The ratings of the selection criteria and their impact on the success of an ERP system selection process, according to the geographical base of the organization by continent.

	Base of the organization by continent													
	Europe		North America		South America		Asia		Africa		Oceania			
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	F	Sig.
Cost	3,7	,78	3,9	,84	3,9	,51	3,8	,78	4,1	,67	3,8	,67	1,137	,340
Technology	$3,7^{1}$	,58	4,0	,67	4,0	,51	4,0	,50	$4,3^{2}$	,47	4,0	,55	4,958**	,000
Functionality	4,2	,66	4,4	,76	4,5	,41	4,3	,59	4,5	,58	4,4	,63	1,804	,111
Time	3,4	,73	3,6	,87	3,6	,81	3,7	,75	3,8	,70	3,5	,84	2,028	,074
Market	$3,7^{1}$	,66	3,9	,74	$4,3^{2}$	,59	4,0	,67	4,2	,47	4,1	,65	5,752**	,000
Quality	$3,8^{1}$	,83	4,0	,84	4,1	,73	4,0	,77	$4,4^{2}$	,45	4,0	,65	2,280*	,046
Multilingual	$3,2^{2}$	1,17	$3,3^{2}$	1,31	$3,3^{2}$	1,24	$3,2^{2}$	1,19	2,7	1,50	$2,3^{1}$	1,08	3,639**	,003

Notes: (F) – F-values; (Sig.) – level of significance (**) p<01; (*) p<.05; (SD) - standard deviation; (M) – means; – the mean values are accompanied by superscripts 1, 2 – they signify that value 2 is statistically the highest and 1 is significantly the lowest, at α=0.05 level of significance.

Source: own elaboration

Comparison by continent, reflecting the geographical position of the respondent, was also made (Table 37). Significant differences were found by continent in five of the seven dimensions. The trend of the recipients is quite consistent in the dimensions of technology, time, market, and quality. The ratings of respondents from the European continent were the lowest, while the ratings of respondents from the African continent were the highest on average. In the multilingual dimension, the trend is different - relatively high ratings in South America and low in Oceania.

Table 37. The ratings of the selection criteria and their impact on the success of an ERP system selection process, according to the geographical position of the respondent.

	Base of the respondent by continent													
	Europe		North America		South America		Asia		Africa		Oceania			
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	F	Sig.
Cost	3,7	0,79	3,9	0,84	3,9	0,55	3,8	0,77	4,1	0,64	3,8	0,64	1,014	,409
Technology	$3,7^1$	0,59	4,0	0,64	4,0	0,51	4,1	0,49	$4,4^2$	0,45	4,0	0,58	7,147**	.000
Functionality	4,2	0,70	4,4	0,75	4,5	0,41	4,3	0,57	4,6	0,56	4,4	0,63	1,679	.138
Time	$3,4^1$	0,73	3,5	0,91	3,6	0,80	3,7	0,74	$3,8^2$	0,65	3,5	0,81	2,926*	,013
Market	$3,7^1$	0,71	3,9	0,74	$4,2^2$	0,58	4,0	0,64	$4,2^2$	0,44	4,1	0,61	5,303**	.000
Quality	$3,8^1$	0,84	4,0	0,85	4,1	0,73	4,0	0,74	$4,5^2$	0,46	4,0	0,65	2,688*	,021
Multilingual	3,2	1,18	3,2	1,34	$3,4^2$	1,21	3,2	1,18	3,0	1,60	$2,3^1$	1,10	3,328**	,006

Notes: (F) – F-values; (Sig.) – level of significance (**) p<01; (*) p<.05; (SD) - standard deviation; (M) – means; – the mean values are accompanied by superscripts 1, 2 – they signify that value 2 is statistically the highest and 1 is significantly the lowest, at α=0.05 level of significance.

Source: own elaboration

In the comparison between the countries of the former Soviet Union and the rest of the countries using t-test analysis, no significant differences were found between the countries of the former USSR and the rest of the countries.

Additional analysis was performed using an ANOVA variance test to check the importance of location to the perception of successful selection of an ERP system by comparison and found that it was statistically significant (Table 38).

Table 38. Correlation between the organization's location and the perception of successful selection by continent.

From your point of view, was the selected system a good choice for the organization?	N	Mean	SD	F	Sig.
Europe	165	3,73	1,038	2,521	,029
North America	103	3,92	,848		
South America	31	4,06	,892		
Asia	85	3,94	,807		
Africa	7	4,57	,787		
Oceania	28	4,14	,803		
Total	**419**	**3,89**	**,929**		

p <.05

Source: own elaboration

Significant differences were found according to the various geographical residences of the organizational management's activity in the perception of a successful selection process - F = 2.52; p <.05 (Chart 13.). In Africa, reports on the success of ERP system selection were the highest (4.6 average) and in Europe they were the lowest (average 3.7).

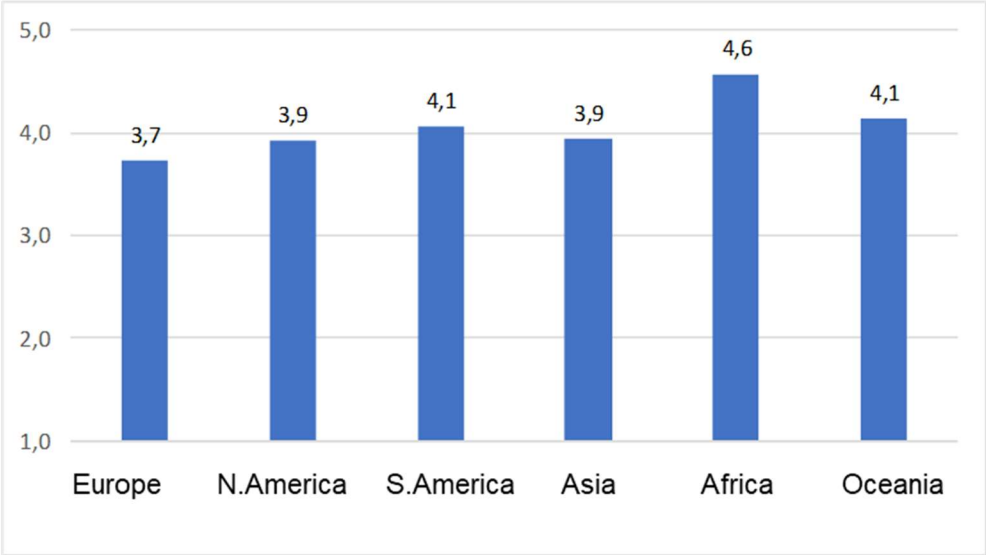

Chart 13. Average perception of successful selection by continent

Source: own elaboration

Concluding the analysis of the data for the current hypothesis, there are differences between the variables which support it and others which are less significant. As a result, the hypothesis was partially supported.

4.4.1.4 H4. The importance of selection criteria to successful ERP system selection varies according to the type of organization.

The hypothesis examined whether there were differences in the ERP system selection process among organizations of different types – For-profit versus Non-profit organizations and Government organizations (Question 19). To test the hypothesis, a one-way ANOVA analysis was conducted.

No significant differences were found between the three types of organization (For-profit, Non-profit, Government) in the participants' perception of the decision making process for selecting an ERP system. Therefore, the hypothesis is not supported.

Additional analysis was performed in order to test whether there were differences by the type of organization (For-profit, Non-profit, government) (question 19) in the effect of prior knowledge based on other similar organizations on the decision making process (question 8). In order to overcome the problem of multiple degrees of freedom in question 8, a reduction was made from 5 to 3 levels: low importance (values 1-2), moderate importance (value 3), and high importance (values 4-5). The analysis was made using a frequency cross-test (Crosstabs) and Chi-square analysis. As shown in Table 39, there are significant differences between the types of organization X^2_4=9.58; p<.05. In Government organizations about two-thirds reported high importance, compared with 56.3% in Non-profit organizations and only 42.4% in For-profit organizations.

Table 39. Importance of other organizations of the same type to selection results.

			Type of Organization		
			For-Profit Corporation	**Non-Profit organization**	**Government Organization**
Importance of other organizations of the same type to selection results	**Low**	**N**	45	0	4
		%	13,1%	0,0%	10,8%
	Medium	**N**	153	7	9
		%	44,5%	43,8%	24,3%
	High	**N**	146	9	24
		%	42,4%	56,3%	64,9%

Source: own elaboration

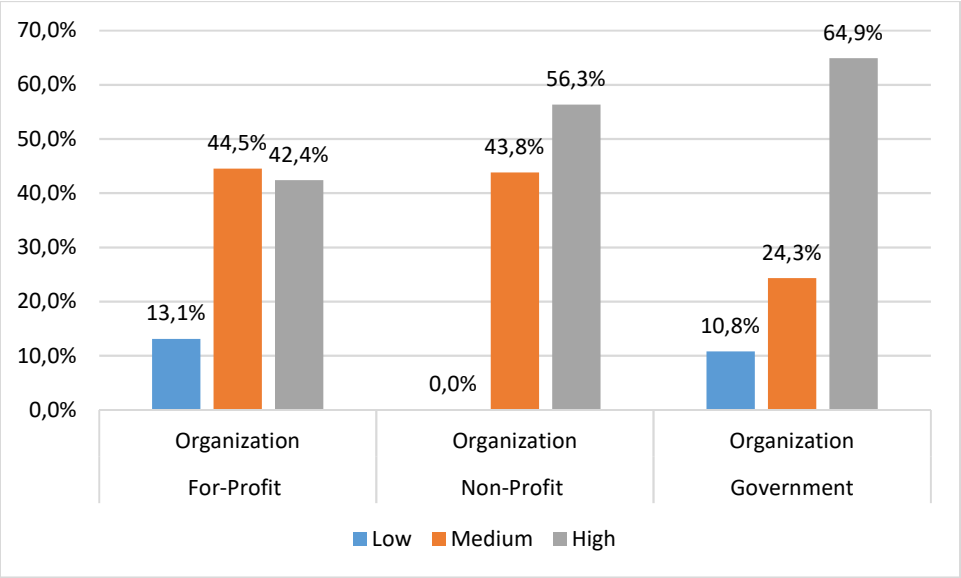

Chart 14. Importance of other organizations of the same type to selection results

Source: own elaboration

Concluding the analysis of the data for the current hypothesis, there were no significant differences found between the variables. As a result, the hypothesis was not supported.

4.5 The second objective of the analysis

The second objective of the present study is to evaluate the importance of decision making methodology and external consultants to the success of ERP system selection.

The following variables were examined as relevant to the second objective, using the following set of questions:

- Question 4: In your opinion, was the selection process of the ERP system professionally done?
- Question 5: If external consultant services were used during the selection process, in your opinion, were the recommendations submitted by the consultant impartial?
- Question 6: If external consultant services were used during the selection process, did the company accept the recommendations of the consultant?

- Question 7: Was there use of a Decision Making Methodology during the ERP selection process?
- Question 9: From your point of view, was the selected system a good choice for the organization?

4.5.1 Hypothesis-testing of H5-H6.

4.5.1.1 H5. When decision making methodology is being used, the indicators for successful selection of an ERP system are higher.

The hypothesis examined the use and non-use of a systematic methodology in the decision-making process (question 7) and the respondents' perception of the success of the ERP system selection for the organization (question 9). A t-test analysis for independent samples was performed.

There was no significant difference in the respondents' ratings of the success of the system selection process between organizations that used a decision-making methodology and those who did not. Therefore, the hypothesis is not supported.

4.5.1.2 H6. With the professionalism of external consultants, the indicators for successful selection of an ERP system are higher.

The hypothesis examined whether there were differences according to the use of an external consultant in the decision making process for successful selection of an ERP system. The independent variables are questions 5 and 6, while the dependent variable is question 9. The test was made using one-way ANOVA analysis, as shown in Table 40.

Table 40. The success of the ERP system selection process and impartiality of the external consultant.

Was the recommendation submitted by him impartial?	**M**	**SD**	**F**	**Sig.**
Yes, the recommendation was impartial.	4,06[3]	,881	5,313**	,001
No, the results were biased.	3,67[1]	,991		
It is hard to tell.	3,56[1]	,984		

No external consultant was used during the selection process.	3,92[2]	,853		

Notes: (F) – F-values; (Sig.) – level of significance (**) p<.01; (M) – means – the mean values are accompanied by superscripts 1, 2 and 3 – they signify that value 3 is statistically higher from 2, and 2 is significantly higher than 1, at α=0.05 level of significance.

Source: own elaboration

There are significant differences in the success of the ERP system selection process for various levels of perception of external consultation impartiality. In other words, the analysis examined whether there were differences in the respondents' perception of the success of the ERP system selection process and their response to the objectivity of the external consultation towards their company in making a decision according to their perception. The independent variables are questions 5 & 6 in the external consultation questionnaire, and the dependent variable is question 9 regarding the success of the process. F=5.31; p<.01: In organizations where respondents reported that the external consultant gave his recommendations impartially (Chart 15), the success of the selection process was higher (4.06) compared to other organizations (3.67, 3.56). However, no significance was found in the different levels of acceptance of the consultant's recommendations and the success of the selection process. Therefore, the research hypothesis was confirmed in relation to question 5 and was repeated in relation to question 6.

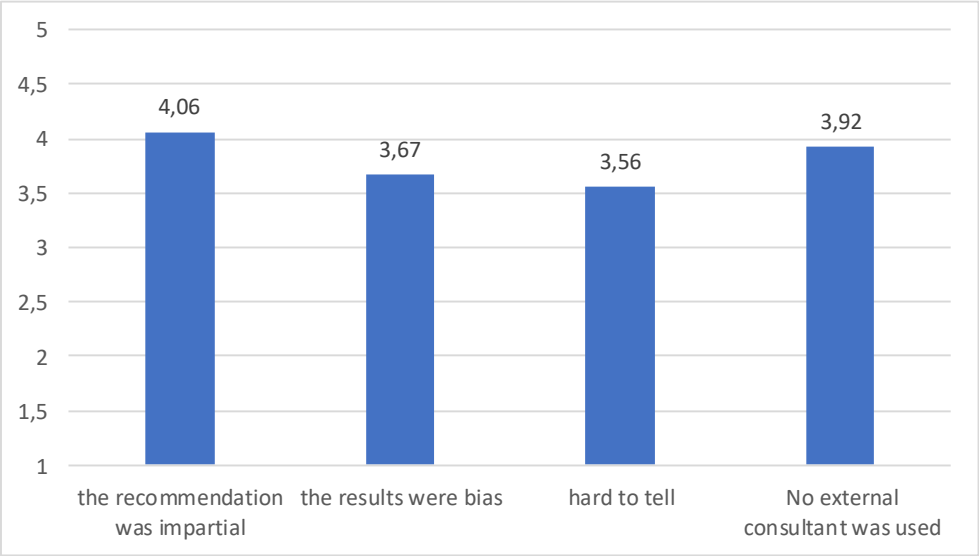

Chart 15. The success of the ERP system selection process and the impartiality of the external consultant

Source: own elaboration

With the purpose of testing the perception of the professionalism of the selection process (Q4) and the acceptance of external consultant recommendations (Q6), an analysis was made using a frequency cross-test (Crosstabs) and a Chi-square analysis (Table 41). As a result, significance was found.

Table 41. Professionalism of the selection process according to the acceptance of external consultant recommendations.

Was the selection process of the ERP system Professionally done?		**Did the company accept the recommendations of the consultant?**			
		Fully Accepted.	**Fully Rejected.**	**Partially Accepted.**	**Second Opinion**
Yes.	N	90	6	66	27
	%	85,7%	100,0%	61,1%	49,1%
No.	N	1	0	3	4
	%	1,0%	0,0%	2,8%	7,3%
Partially.	N	14	0	37	23
	%	13,3%	0,0%	34,3%	41,8%
Not relevant.	N	0	0	2	1
	%	0,0%	0,0%	1,9%	1,8%

Source: own elaboration

The results show the importance of receiving the external consultant's advice in reporting that the project was conducted professionally $X^2_9=31.87$; $p<.01$: In companies which received the advice fully, a higher percentage reported a professional process than companies which partially accepted the counselling or asked for another consultant's opinion.

In the category "fully rejected", there are a total of six respondents and all six of them also noted that the process was professional, which can be treated as though it contradicts the rest of the findings in this case.

Concluding the analysis of the data for the current hypothesis, there was significance found between the variables which support it. As a result, the hypothesis was supported.

4.6 The third objective of the analysis

The third objective of the present study is to evaluate the importance of the organizational environment in the use of decision making methodology.

The following variables were examined as relevant to the third objective, using the following set of questions:

- Question 7: Was there use of a decision making methodology during the ERP selection process?
- Question 15: What is the company's decision making unit regarding ERP selection / headquarters location?
- Question 16: What was the location of your position during the ERP system selection process?

4.6.1 Hypothesis-testing of H7.

4.6.1.1 H7. The frequency of use of decision making methodology increases when there are such tendencies in the organizational environment.

One aspect that was examined was the demographic data and its importance to the use of decision making methodologies. The test analysed whether the use of a decision making methodology in the system selection process (question 7) is dependent on a geographical region (question 15), based on the assumption that organizational culture varies among regions. The analysis was carried out using a frequency cross-test (Crosstabs) and Chi-square analysis. The following table presents the significant findings only. The two geographical divisions were found to have significance according to: European Union countries vs non-EU countries and the different continents. The findings are presented as follows.

Table 42. The use of a methodology according to an organization's geographical base (in the EU or others).

	Use of a Decision Making Methodology			
	Yes		**No**	
Geographical base of the organization	**N**	**%**	**N**	**%**
European Union	77	64.2%	43	35.8%
Others	225	80.1%	56	19.9%

X^2_1=11.44; p<.01				
Geographical position of the respondent	**N**	**%**	**N**	**%**
European Union	78	67.8%	37	32.2%
Others	224	78.3%	62	21.7%
X^2_1=4.86; p<.05				

Source: own elaboration

Comparison between EU countries and other countries (Table 42): There are significant differences in the percentage of organizations using decision-making methodology: among organizations based in the EU, there was less use of methodology (about 65% used) compared with organizations in other countries (about 80% used). In other words, EU countries use decision-making methodologies less.

Table 43. The use of a methodology according to an organization's geographical base (by continent).

	Use of a Decision Making Methodology			
	Yes		**No**	
Geographical Base Of The Organization	N	%	N	%
Europe	92	65.7%	48	34.3%
North America	72	85.7%	12	14.3%
South America	19	65.5%	10	34.5%
Asia	48	77.4%	14	22.6%
Africa	2	66.7%	1	33.3%
Oceania	24	100.0%	0	0%
X^2_5=21.36; p<.01				
Geographical Position Of The Respondent	**N**	**%**	**N**	**%**
Europe	94	68.6%	43	31.4%
North America	60	84.5%	11	15.5%
South America	21	63.3%	12	36.4%
Asia	58	76.3%	18	23.7%
Africa	3	75.0%	1	25.0%
Oceania	22	100.0%	0	0%
X^2_5=16.17; p<.05				

Source: own elaboration

Comparison of continents (Table 43): There are significant differences in the proportion of organizations using decision-making methodology across continents: The findings indicate large differences between the continents, with the highest rate of users of decision making methodologies in North America (about 85%) and the lowest in Europe and South America (about 65% of users).

In addition, with the purpose of testing the level of influence of firms in the industry and the use of decision making methodologies, a t-test was performed and significance, as specified below, was found (Table 44).

Table 44. Influence of firms in the industry and the use of decision making methodology.

	Was there use of a Decision Making Methodology during the ERP selection process?					
How strongly was your company's selection of an ERP system influenced by its knowledge about the choices made by other firms in the industry (competitors, vendors, customers)?	**Yes**		**No**			
	M	**SD**	**M**	**SD**	**t**	**Sig.**
	3,4	1,03	3,1	1,19	2,25*	,025

p<.05

Source: own elaboration

Significance was found in the current test, t = 2.25; p <.05: In companies which used a decision-making methodology, respondents reported higher ratings, on average, for the importance of knowledge about decisions made by other organizations on their decision-making process.

Concluding the analysis of the data for the current hypothesis, there were significant tendencies which support it and they were found in several aspects between the variables. As a result, the hypothesis was supported.

4.7 Conclusion

In the current chapter, the data was collected with the use of a survey instrument and, based on the literature review, it was analysed with the use of statistical tools. The results of the statistical analysis were used for research objective analysis and the testing of the hypotheses. The analysis showed mixed conclusions reflecting the complexity of the selection process of the ERP system, and contradictory differences were often reported between the variables. Summarizing the testing of the hypotheses, three of them were not supported (H1, H4, H5), two of them were partially supported (H2, H3), and two were supported (H6, H7). Additional statistical analysis was presented, allowing a wider view of the data collected. In the following chapter, the results will be discussed and explanations will be suggested.

5 Discussion and conclusions

5.1 Introduction

The discussion of the findings introduced in the previous chapter is designed according to the structure of the methodology and the results chapters. The results are explained and interpreted using key elements of the research objectives, research questions and hypotheses in the context of the previously presented research. During the discussion, the results are highlighted and validated with findings from the literature. The limitations of the present study are stated and explained as part of this chapter, including survey reviews. The implications of the findings for academic and management practice are reviewed with the addition of a future research perspectives overview. Finally, conclusions regarding the major results are presented with a statement regarding their relationship to the research problem.

5.2 Research findings discussion and analysis

The research problem, as stated in previous chapters, consists of several aspects that may possibly have an impact on the ERP system selection process, along with the described gap in predefined patterns for the ERP system selection process. These aspects, which include factors relevant to the decision making process, were formulated as three general objectives which defined the main targets of the conducted research. The first objective was to estimate the differences in the characteristics of organizations by determining the selection criteria rankings and their importance to the success of ERP system selection. The second objective was to evaluate the importance of decision making methodology and external consultants to the success of ERP system selection. The third objective was to evaluate the importance of the organizational environment in the use of decision making methodology. The results of the research indicate the importance of organizational characteristics to the perception of the selection as being successful. The study demonstrates the importance of some of the organizational characteristics, such as location and size, to successful ERP system selection, while other organizational characteristics, industry type and the type of organization, have no importance. The analysed results confirm that the use of professional external consultant services is valuable in successful ERP system selection and also that the organizational environment is essential in the use of decision making methods. At the same time, the data suggests that the use of decision making methodologies has no importance regarding the successful selection of an ERP system.

5.2.1 Role of the ratings of selection criteria and their importance to successful ERP system selection between industry types.

The first objective research questions were designed to estimate the differences in the characteristics of organizations when the target was determination of the selection criteria ratings and their importance to the success of ERP system selection. The first question inquired whether industry type driven ratings of the selection criteria were important to successful ERP system selection. The literature review performed in the preliminary stages of the current research revealed a massive number of case studies concentrating on the connection, influence and results of applying different sets of selection criteria in various industries' ERP system selection processes. Here is a short list of studies by industry - Electronics - Lin, Chen, and Ting (2011); Textiles - Cebeci (2009); Manufacturing - Baki and Çakar (2005); Airlines - Kilic, Zaim, and Delen (2014); Construction - Mexas, Quelhas,and Costa (2012); Automobiles - Galankashi, Helmi, and Hashemzahi (2016). The large quantity of studies analysing this connection underlines that there is an assumption that the industry type is a factor which is important to the selection criteria ratings and as a result to the successful selection of an ERP system. This assumption was tested by hypothesis H1, analysing whether the importance of selection criteria to successful ERP system selection varies according to the type of industry. The results of the analysis show no importance of industry type driven selection criteria ratings in the perception of a good choice of ERP system. This result does not confirm the hypothesis, which can be an indication that differences in the selection of criteria ratings have no relevance to the variety of the industry types. In other words, if an A type industry is using a set of selection criteria which have ratings of importance that are different from the ratings in a B type industry for the same set of criteria, the success of the selection process is not defined by the industry driven ratings given to the criteria. Another perspective on the industry type's relevance to a successful selection process examined the meaningfulness of information about other organizations from the same core industry, and their selections of ERP systems, to the successful selection process of the original organization. The results of this analysis indicate its significance. This means that the more the organization uses information from the experience of other organizations in the decision making process, the more likely the selection process will be successful. This contradicts the finding that there is no difference between industries in the ratings of criteria. Or alternatively, there is no importance in the type of industry when recommendations are being used. These results

might suggest that it is important for decision makers to be aligned with or at least be aware of the decisions made by other organizations from the same industry, but in the end there is no significant difference in the ratings given according to industry type concerning the success of the selection process. In other words, based on these results, managers can rely on or take into consideration decisions made by organizations regardless of the type of industry. This interpretation can offer additional support to some aspects of the selection process, such as a vendor's list of ERP system software which can be based on industry type resemblance between organizations, as is described in the literature (Umble, Haft, & Umble, 2003).

5.2.2 Importance of selection criteria ratings to successful ERP system selection and the way they differ by the size of the organization.

The second question examined the importance of organizational characteristics to selection process success from a different angle and inquired how the size of the organization changes the ratings of the selection criteria and their importance to successful ERP system selection. Organizational size is one of the popular forms of deviation mentioned in the literature. Company size may influence many aspects relevant to the ERP system selection process, including budget, functional needs, schedule, amount of potential users and more. Thus, it can be considered a reasonable assumption that there should be differences in the way different size organizations will rate the importance of criteria in the selection process. Evidence of the frequent application of such deviation where the approach is paired with the organization's size can be found in many studies including: Gable (2003); Sedera (2008); Kilic, Zaim, and Delen (2015); Bharathi and Mandal (2015) and more. This assumption was tested by hypothesis H2, analysing whether the larger the size of the organization, the greater the importance of deciding on some of the ERP system criteria for successful ERP system selection. The results of the analysis show significant differences according to the size of the organization in the respondents' perceptions of the effect of the Functionality, Market and Multilingual criteria on a successful decision making process for selecting an ERP system. In this case, it means that larger organizations give greater importance to the criteria of system functionality, market and multi-language. In contrast, the criteria of cost, technology, time and quality ratings are not found to differ significantly according to the size of the organization. These results can be explained by the readiness to compromise on the criteria of functionality and multilingual abilities of the selected system by small and medium sized organizations, as well

as on consumer preferences, the market share of the system, the vendor's reputation and the vision that composes the market criteria. It could be suggested that the functional abilities of the system needed by small and medium (SME) organizations may be more limited and often they are ready to settle for less, gaining simplicity and cost reduction. Many of the functionalities offered by ERP systems can be less relevant and will not be in full use in an SME organization, and so some features can be left out without impairing the crucial performance capabilities. The multilingual criterion can be less important to SMEs due to the nature of their business, often concentrated on a local, single-language territory as opposed to the large, global enterprises which are often spread and deployed over the world, making this feature of the system crucial. The market criterion can be less relevant for small and medium size companies due to their limited ability to influence the vendor's character and manner of conduct, at the same time setting conditions can significantly reduce the selection options to them. Thus, SMEs prefer to focus on other criteria. The results indicating no significance in the cost, technology, time and quality criteria ratings can be interpreted as crucial for any type of ERP system project, especially as they receive similar ratings from all respondents regardless of the organizational size. When examined without dependence on whether the selection process was successful, the technology criterion is actually considered significant from the organization size perspective. This can be explained by the importance to the decision maker this criterion represents during the selection process for a large organization, while it is not relevant as a factor in the perception of successful selection for all sizes of organization. An additional test presented in the results shows that there is no importance of organizational size in the perception of a successful selection process. This can emphasise the importance of an efficient and high quality selection process regardless of the size of the organization. Another test performed during the results analysis shows that there is no significance according to the different sizes of organization in various industries and the way they rate the criteria. In other words, the size of the organization is a factor that matters regardless of the industry type when rating the importance of the criteria. These findings support previous research performed in order to reveal the connection between different sized organizations and their perception of the success of an ERP system (Sedera, 2008). The research confirmed differences in the perception of success according to several factors. This can support the idea that there are differences based on organizational size during various phases of the ERP system implementation project, including the selection process and later phases.

5.2.3 Importance of selection criteria ratings to successful ERP system selection by the geographical location of the organization.

The third question examines different ratings of the selection criteria by the geographical location of the organization and its importance to successful ERP system selection. Culture, economy, language, government, corporate politics, management style, government regulations, time zones and labour skills are all points of difference originating in the geographical location of ERP projects (Ein-Dor, Segev, & Orgad, 1993), which can be assumed to be important factors regarding the selection process and its successful result. Management style, specifically, can influence implementation approach and implementation project duration (Sheu, Chae, & Yang, 2004). Analysis of these aspects might reveal a pattern which can enrich the understanding of the success or failure of a selection process from the location perspective. There is only partial evidence found in the reviewed literature which examines the connection between location and selection criteria. The absolute majority of location oriented studies concentrate on a specific country analysis and not comparative analysis with the aim of revealing differences.

The assumption was tested by hypothesis H3, analysing whether the locations of organizations are important to the ratings of selection criteria and their relevance to successful ERP system selection. The analysis was made by dividing the countries into groups as described in previous chapters. The results indicate significant differences in 4 criteria ratings given by EU countries and Non EU countries, including: technology, time, market and quality. The data analysis shows that in these four criteria, respondents in organizations based outside the EU gave higher ratings than respondents in organizations based in the EU. On the other hand, there were no significant differences in the following ratings: cost, functionality and multilingualism. These findings can be explained by the difficulties experienced in Non EU countries regarding technology, time, market and quality issues and as a result they were rated significantly higher, which can emphasise the concern about failure in these factors. In the comparison made between EU and Non EU European countries, no significant differences were found, which can be explained by the relatively minor differences between these country groups in the rated criteria. In the comparison made between 6 continents - Europe, North America, South America, Asia, Africa and Oceania, significant differences were found in four criteria. The technology criterion received a higher rating than any other criteria from the

organizations in Africa and the lowest in European organizations. The market criterion received the highest ratings in South America and Africa, while Europe had the lowest average ratings. The quality criterion received higher ratings than any other criteria from the organizations in the African continent and the lowest in European organizations. The multilingual criterion received higher ratings in the continents of Europe, America and Asia, and significantly lower ratings in the continent of Oceania. These results can be explained from the perspective of the following question - *what most concerns managers when making a decision about ERP system selection?* Less developed continents such as Africa and South America rate the factors that are less certain to be achieved during the implementation process of an ERP system significantly higher, such as technology; vendor with a solid market position and attitude; and the quality of the selected system. European organizations, judging by these results, are less concerned with these factors and maybe expect to achieve them by default. European, American and Asian countries which have globally spread businesses have significantly higher ratings for the importance of multilingual abilities in the selected system than developing African countries' companies and remote Oceania-based organizations. These results remained consistent when the analysis was made according to the geographical position of the respondent.

In the comparative analysis between the countries of the former Soviet Union and the rest of the countries, no significant differences were found and that can be an indication of the relatively minor differences between these country groups in the rated criteria. When analysing the perception of successful selection by continent, however, significant differences were found. The ranking of continent from the highest perception of successful selection to the lowest is as follows: Africa, South America, Oceania, North America, Asia, and Europe. These results can be explained by cultural differences in the way a performed process is ranked and appreciated.

These findings contradict the interpretation of criteria ratings which suggests that concern over quality, low technology level and market leading systems could not be selected in Africa and South America. The current study supports the described results of other research, introducing differences between developed countries and developing countries regarding selection criteria importance determination (Baki & Çakar, 2005). Another study which presents the country dependent survey results of selection criteria is a European survey which

included 2,647 mid-size companies from 10 European countries (Finland, Sweden, Norway, Denmark, the Netherlands, Belgium, France, Spain, Italy, and the UK) and 6 industry sectors (Everdingen et al., 2000). The researchers suggest a summarised criteria ranking for all the European countries that participated in this order of importance: Product functionality, Product quality, Implementation speed, Interface with other systems, Price, Market leadership, Corporate image and International orientation. In the current study, the ranking order of criteria importance in European countries is: Functionality, Technology, Quality, Cost, Market, Time, and Multilingual. The rankings of both studies are similar, with slight differences and less generic grouping in the earlier study, which supports the collected data and results analysis of the current research. The presented study findings contradict another study which compared ERP system CSF rankings in developed and developing countries, concluding that the rankings generally have a similar pattern (Asemi & Jazi, 2010).

5.2.4 Importance of organization type to the ratings of the selection criteria and their significance to successful ERP system selection.

Research question number 4 addresses the issue of possible differences between various types of organizations in the ratings of the selection criteria and their significance to successful ERP system selection. One of the parameters of the traditional deviation of organizations is their organizational nature, and ERP system projects are no exception (Beheshti, Blaylock, Henderson, & Lollar, 2014). In the current research survey, the organizations were divided into For-profit, Non-profit and Government organizational types. These types of organizations, by definition, have different goals and visions which can be translated into different criteria ratings patterns and perceptions of successful selection processes.

The assumption was tested by hypothesis H4, which analysed whether the importance of selection criteria to successful ERP system selection varies according to the type of organization. The results indicate no significant differences in the ratings of the criteria and the perception of successful selection processes between different organizational types. In other words, managers in different types of organizations have similar points of view on the importance of the selection criteria which lead to the successful selection of an ERP system.

In order to have a better understanding of the different patterns of selection between organizations of different type, an additional analysis was performed to reveal whether there were differences according to the type of organization in the effect of prior knowledge based on other similar organizations on the decision. The results show that there are significant differences, as in Government organizations about two-thirds reported a high effect compared to about a half in Non-profit organizations and less than a half in For-profit organizations. This can be explained by the more common collaborations between governmental organizations than among other types of organizations. This can also be attributed to the fact that government organizations are ultimately subordinate to a unified government that allows, encourages and sometimes even requires reliance on the experience of other subordinate organizations. These findings confirm that there are some differences between organizations of different types regarding certain aspects of decision making during the ERP system selection process. Comparing the results with previous studies which compared these organizational types in managerial aspects shows mixed results (Baarspul, 2009). Some influential studies in the field of organizational types indicated minor or negligible differences between public and private sector organizations' management in terms of the decision making process (Rainey& Bozeman, 2000), while others indicate the opposite tendencies. Studies that investigated the differences in information systems field managerial behaviour in private and public types of organizations showed differences (Rocheleau & Wu, 2002).

5.2.5 Importance of decision making methodology to successful selection.

The second objective research questions were designed to evaluate the importance of decision making methodology and external consultants to the success of ERP system selection. The target was to determine the importance of the environmental aspects to the methodological process and the selection's success. Research question number 5 addresses, respectively, the issue of the use of selection methods based on decision making methodologies and the successful selection of an ERP system. In previous chapters of the presented research the literature review was conducted and revealed numerous multi criteria decision making selection methods applied and theoretically examined in order to improve the chances of successful ERP system selection. A total of 189 publications with specific

application of MCDM on the ERP system selection process, and 3,374 citations, were issued between the years 2000-2016. This relatively large number of publications and overall interest in that field of knowledge can indicate a common assumption that the use of decision making methodologies is important in successful ERP system selection. This assumption was tested by hypothesis H5, analysing whether the indicators of successful selection of the ERP system are higher when decision making methodology is being used. Contrary to the hypothesis, the results of the analysis showed no significant difference in the respondents' perceptions of a successful system selection process according to whether the organization used a decision making methodology during the selection process or not. These findings, contrary to the hypothesized association, can be explained by the different experiences of the managers who responded to this question. In other words, a manager who has experimented with applying a decision making methodology and has reached a successful outcome for the selection process assumes that there is a link between the two. A different manager who has achieved a successful outcome without using a decision making methodology does not see a connection between the two.

It is possible to assume that in order to find valid differences between the two variables, the managers participating in the survey should only be those who have taken part in both types of project (with or without the use of decision making methodology) and can attest to the differences if such do exist. However, this test would also not be flawless because there is still the possibility of distortion caused by differences in other factors in the selection process such as the type of methodology used, the proper use of the methodology, the good implementation of the system, according to which it was possible to determine whether the choice was good and more. In the reviewed literature there are several contradictory assumptions regarding the reasons why managers who have access to MCDM methods choose to use them or not in their decision making processes. One of the approaches suggests that the MCDM methods are oversimplified and cannot support real world complex problems and decision making processes (Kasanen et al., 2000). Another suggests that the over-complexity and mathematical orientation of the MCDM methods make them incomprehensible to managers and that can be a reason why they prefer not to use them (Zionts, 1979). If one of these explanations is accepted, it is a reason for managers with similar agenda to totally ignore the option of using this tool as a part of their decision making process. In this case, only solid

proof of the benefits of using MCDM methods can be a reason to change this approach. A search for evidence of extensive research conducted in order to compare the influence of the application of MCDM methods on the result of a selection process was in vain. The majority of research in this area concentrates on MCDM application or the advantages and disadvantages of each MCDM method, but no consistent research into the contribution of using these tools versus using other tools was detected. At the same time, these results correspond with the tendencies visible in the dynamics of MCDM publication analysis (Figure 10), indicating a reduction in publications in recent years.

Another explanation of the results presented in the current study can be that using decision making methodologies contributes to a successful selection process in a similar way to other selection tools and there is no significant advantage to using decision making methodologies from the results perspective.

5.2.6 Role of external consultants in the successful selection of an ERP system in different organizations.

Research question number 6 addresses the importance of using the services of professional external consultants for the successful selection of an ERP system by an organization. In ERP implementation projects, the use of external consulting services is common practice during all project phases (Bingi, Sharma, & Godla, 1999; Ahituv et al., 2002; Hsu, Sylvestre, & Sayed ,2006; Maditinos, Chatzoudes, & Tsairidis, 2011; Haddara, 2018). In some cases, the organizations use the same external consulting firm for the ERP system selection process and for supporting the implementation process as an outsource provider during the project phases. Consulting firms can maintain beneficial business relationships with some ERP system providers that can cast a potential shadow over their reliability when selecting the system (Piturro, 1999). The assumption that with the professionalism of external consultants the indicators for successful selection of an ERP system are higher was suggested in Hypothesis H6 and analysed. In line with the hypothesis, the results show that the use of external consultant services is important to the successful selection process. This result can be explained by the experience and professionalism an external consultant can bring to the selection process. Especially in organizations previously not familiar with a selection process and its consequences, the role of the external consultant can be crucial both for the success and failure of the selection process. A consultant's knowledge can infuse a process with the

atmosphere of something that is being carried out efficiently and progressively. Additionally, based on the results, it can be stated that organizations which confirmed the impartiality of the consultant's recommendations show a higher level of perception of successful selection compared with respondents who reported that biased recommendations were given. This perception by managers can be explained by the significant trust that managers have in external consultants during the process of selecting the system as well as confidence in their fairness. The results also show the frequent perception of a professionally implemented project together with full acceptance of the consultant's recommendations. In other words, there is a perception among managers that a selection process carried out professionally by consultants can be fully approved without the need for a second opinion. This can indicate the dependency some managers experience, totally relying on professional help during the selection process without questioning the accuracy of the given recommendations. On the other hand, there is no evidence in the results that recommendations that were fully accepted were relevant to the successful selection process. This important result can suggest that despite the high level of trust given to the external consultant there is no proof, in the current research, that full acceptance of the consultant's recommendations guarantees a successful selection process. Previous studies support the use of external consultants if they are independent and not linked to one of the vendors because they tend to be impartial and not favour some of the products by definition (Ratkevičius, Ratkevičius & Skyrius, 2012).

An additional aspect which shows differences in the results analysed in the current study is the subjective and objective decision making process. As presented, there is no evidence that supports the use of decision making methodologies for achieving successful results. Alternatively, there is evidence for improving the chances of achieving successful selection results by using professional consultant services. These results contradict previous research that describes the use of MCDM methods as a compromise-based objective decision making process that can achieve approval and support among diverse stakeholders during the selection process. On the other hand, other subjective decision making processes which are not based on using decision making methodologies can lead to problematic relationships and internal business conflicts which, in turn, can result in less than optimal results (Önüt, Kara, & Işik , 2009; Molnár, Szabó , & Benczúr, 2013). Integrating this perspective into the current research can lead to the next conclusion: The use of an external consultant which is not

supported by a decision making methodology and driven only by his experience and knowledge can be classified as a subjective decision making process and become a potential threat to the successful selection process.

5.2.7 Role of the organizational environment in the use of decision making methodology.

The third objective research question was designed to evaluate the importance of the organizational environment in the use of decision making methodology.

Research question number 7 deals with the importance of the organizational environment in the use of decision making methodology. Under the category of environment, there are demographic and industry aspects, such as: the geographical base of the organization, the importance of the type of industry, and the use of an MCDM. The main goal of this research question is to investigate the different aspects of the organizational environment and behaviour and their value to the use of decision making methodologies. Hypothesis H7 suggests that the frequency of use of decision making methodology increases when there are such tendencies in the organizational environment. The results indicate significant differences between EU and Non-EU countries regarding the use of decision making methodology during the selection process. About 65% used decision making methodologies in the EU, while in all other countries about 80% used decision making methodologies. Oceania leads with 100% use, North America follows with about 85%, Asia is not far behind with about 77% and South America has as low a percentage (65%) as EU countries.

This can be explained by cultural differences and local market tendencies. Additional analysis could examine whether there is correlation between the use of external consultant services or MCDM methods as interchangeable decision support tools in different country groups. In other words, complementary analysis for a deeper understanding of the results discussed will need to focus on the question of whether countries which tend not to use MCDM methods mostly rely on consultants. A reviewed previous study, focusing on research regarding MCDM in different countries, reports the amount of publications in this field of study between the years 1977-2016. The results of the top 10 contributing countries are divided as follows (converted to percentages and grouped into continents to match the current research data presentation) – Asia 68%, N. America 17% and EU 14% (Yu, Wang, Zhang, & Zhang, 2018). The general tendency remains that the European Union countries contribute least to the MCDM research field. The slight differences between the current and

previous research can be explained by the type of research conducted. Where the previous research focused on academic publications made by different countries over a period of time, the current research presents reports filed by managers regarding the previous year's projects they took part in.

Another result analysis demonstrates significant differences in the use of decision making methodologies and the influence of selections made by other organizations in the industry. Organizations which used MCDM methods reported a higher influence of other companies on their selection. These results support the assumption that the environment is important when taking the decision to apply MCDM methods to the selection process. This can be explained by the need of the organization to receive re-approval of their choice to use MCDM methods or vice versa, receiving re-approval of selections which were similar to other organizations in the industry by using more objective MCDM methods. It can also be assumed that the market criteria can be rated highly by companies that rely on other organizations' selection processes. In line with the hypothesis, these results can suggest that organizations are not indifferent to their environment concerning the ERP system selection process.

5.3 Limitations and scope for further research

This part of the chapter describes the limitations that were encountered in this thesis.

The reliability of the data retrieved from the survey was limited by the way it was conducted. A social networking platform enables access to a multinational range of managers and functional specialists with the experience and knowledge relevant to the survey. On the other hand, it is limited by a lack of personal contact that is available in the interview type of survey, for example. In other words, there was a need to rely on what is stated by the respondents as their experience and field of knowledge without a way of personally confirming it. Nevertheless, there were several activities performed in order to minimize the chances of possible deception, including: finding mutual contacts who could confirm the respondents' professional information; checking the reliability of the answers given; data cleansing of missing and partial data; establishing personal contact via the platform in order to confirm the information given etc.

Another limitation of the survey is the gaps in information regarding the previous and current experience of the respondents. In order to encourage respondents to participate, the number of personal questions was reduced to a minimum. As a result, the information regarding the experience of the respondent was left out. Partly, this type of data was derived from questions about the age of the respondent, and the roles and positions they had experience in.

Additional data that were left beyond the scope of this study were the cloud solution tendencies of ERP systems. Although it was part of the collected information it was not relevant to the research objectives and will become a subject for future research.

5.4 Reviews of the conducted survey

As part of the survey review, in order to improve future research survey quality, a list of reviews was collected from several respondents with suggestions and criticisms regarding the conducted survey. These meaningful responses, which were given voluntarily, serve as proof of the great interest and commitment of some of the respondents to the purposes of the research.

The following are the main issues reported.

1. There is no reference to the past experience of the respondents. It can be assumed that there is a difference between those who participated in one project and those who participated in multiple projects.
2. Questions regarding experience should be focused on specific project experience or overall experience. Otherwise there is no consistency.
3. Questions about the position of the respondent at the time of the project should be of multiple-choice type since people change positions during a project.
4. There were no questions about the time frame in which the project was being conducted and what its financial value was.

5.5 Implications for academic study

The state of the art element presented in the current research described the decision making part of the ERP system selection process.

Deep investigation of the selection process is important for a better understanding of the later phases of the implementation process because when managers rate the criteria, following their previous experience, it reveals their concerns and the failure points noted by them during their practice. These insights can be critical for improving the chances of successful selection and implementation.

From a contribution point of view, the research focused on two specific subjects which have great potential to play a critical factor in the success or failure of the selection process and as a result, the entire ERP implementation project. First, a detailed review of the selection criteria roles, common assumptions and applications to the selection process was introduced. Selection criteria grouping was suggested, with the intention of minimizing the gap caused by the lack of a widely accepted closed list of criteria. The grouping of criteria was constructed on the basis of a thorough literature review (Illa, Franch & Pastor, 2000; Teltumbde, 2000; Hossain & Shakir, 2001; Baki, & Çakar, 2005; Ma, Pearson, & Tadisina, 2005; Wei, Chien & Wang, 2005; Keil & Tiwana, 2006; Jutras, 2007; Perera, & Costa, 2008; Karsak & Özogul, 2009; Ünal & Güner, 2009; Hua & Song, 2010; Hailu & Rahman, 2012; Moller & Chaudhry, 2012; Ratkevičius et al. , 2012; Chen, Liang, & Hsu, 2015; López & Ishizaka, 2017). The contribution of this part of the research was the presentation of a self-elaborated categorization and grouping process for the selection criteria. Retrieved from the literature, a short list of 7 top level selection criteria was generated, as an outcome of systematic generalization of various selection criteria from numerous studies. The list included - Cost, Time, Functionality, Technology, Market, Quality and Multilingualism of the system as top level selection criteria. This list, used in the next steps of the current research, can be reviewed and possibly widely used, along with the criteria sorting questions, as common ground for further research in this field. The sorting questions should assist the grouping of any specific criteria to one of these 7 top level criteria.

Second, a detailed review of the decision making tools being used and specifically the Multi Criteria Decision Making methods was presented. Deep and comprehensive research was conducted in the literature review, comparing methods both of managerial aspects and

studies conducted in this field of knowledge, describing the advantages and disadvantages of each method, and analysing the publication tendencies between the years 2000 and 2016 (Brzozowski & Birfer, 2017). The publication analysis presented a quantified result that contributes by providing numeric evidence of the popularity of some MCDM methods and the general direction of studies in the field of MCDM theoretical and practical applications for solving the ERP system selection problem. After the data collection and review, the different types of MCDM methods were grouped into 4 self-elaborated sets that allowed simplification of the publications analysis and its clearer presentation. The studies and citations were classified under Classic, Fuzzy, Integrated and Other groups. The results emphasize the high volume of AHP MCDM methods application. Classic and integrated sets of methods were revealed as being preferred to the rest of the methods and a high number of unique studies suggesting new methods were noted. Additionally, a generally decreasing number of studies on MCDM methods application in recent years was reported. The analysis showed a demand for a combined, integrated method which can offer a solution for both the qualitative and quantitative parts of the decision making process when MCDM methods are being used.

The following parts of the research dealt with a survey intended to collect information relevant to the selection process as is being practiced by managers in the “real world”. The conducted survey presented a unique worldwide sample of managers and other stakeholders relevant to the ERP system selection process from a variety of industries and organizational types. The results of the survey were analysed and validated using research hypotheses.

The first part of the analysis focused on the selection criteria ratings and their importance to the independent variables, including industry type; size, location and type of organization; and the dependent variable of successful system selection. The analysis provides a new insight into the value of organizational characteristics to the successful selection process of an ERP system.

One of the important conclusions drawn from the analysis is that there is no evidence that industry type is relevant to the ratings given to the selection criteria and does not define whether the selection process will be successful. As described in the discussion part, the assumption that there are differences in the perception of importance of some of the criteria in various industries and that this is valuable to the successful selection result in these industries, is commonly observed in the literature (Baki & Çakar, 2005; Cebeci, 2009; Mexas,

Lin, Chen& Ting, 2011; Quelhas & Costa ,2012; Kilic, Zaim & Delen ,2014; Galankashi, Helmi & Hashemzahi, 2016). As a result, many studies are industry specific and their conclusions are associated with the industry type. The current study suggests another view of these aspects which can encourage researchers to pursue another way of examining their methods and ideas without narrowing themselves to one industry type. Based on these results, research can include a wider spectrum and make a comparison between studies based on various industry types without the need to limit the reservoir of publications. Organizational size is another characteristic that studies are commonly divided by (Bernroider & Koch , 2001). Following the results of the current research, the variance between organizations of different sizes does not apply to all the criteria being rated. This can contribute to the understanding of organizational nature and how it is reflected during the selection process. For example, it is possible, judging by the results of the current study, that when investigating the importance of criteria to successful selection more than one size of organization can be compared according to the criteria of Cost, Time, Quality and Technology and should be specifically examined according to size for the criteria Functionality, Market and Multilingual.

Another organizational characteristic that is commonly examined when academic research is conducted is geographical location Shanks et al. (2000). The current study's results indicate that geographical location is important to the ratings of selection criteria. These results should be taken into account when considering what the basis of investigation should be. In this case, the results support the common management science practice of investigating the selection process in specific countries or regions. From the results, it also can be concluded that there are substantial, continent driven, differences in ratings patterns for selection criteria according to their importance to the successful selection process. Understanding the origin of these differences can contribute to further research on the selection and implementation process. These findings contradict a previous study that found no significant differences between the developing and developed countries' patterns of criteria rating (Asemi & Jazi, 2010).

Organization type was another characteristic analysed in the current research from the perspective of criteria rating and selection process success. The type of organization is often defined in the literature as For-profit, Non-profit or Government type (Baarspul, 2009). The current research shows that there are no differences according to these types in criteria rating.

The importance of this knowledge is the ability to focus on other characteristics that have influence on the process, such as location or the size of the organization, in future research.

The second part of the analysis focused on the use of decision making methodologies and external consultancy services regarding their value to a successful selection process as well as the organizational environment. The presented analyses contribute to a better understanding of the different attributes that are important in the selection and implementation process. The decision making process by application of MCDM methods for an ERP system selection process is frequently presented and discussed in the literature and examined in the current research. As shown in the current analysis, the advantages of using decision making methodologies for the selection process are not certain. The results of the performed survey demonstrate no significant differences supporting the use of decision making methodologies as a contributor to the success of a selection process. This conclusion can be meaningful for re-examination of the benefits of using MCDM methods for an ERP system selection process. On the other hand, the use of consultant services for supporting the selection process did not receive significant coverage in the literature and was not examined in comparison to the results of applying decision making methodologies. The current study's analysis demonstrated the significance of the use of external consultant services and their value to the successful selection process of an ERP system. This new knowledge contributes to management science and adds a new point of view on the way a selection process is actually carried out.

Another aspect described as a result of the current research is the importance of geographical location to the use of decision making methodologies. The tendency of a continental pattern to using or not using MCDM methods was found to be significant and indicates that there are differences in the local approaches of whether to use decision making methodologies or not. This result, in combination with previous results regarding the uncertainty of the advantages of using decision making methodologies, can be discussed from the perspective of the general success or failure of implementation projects related to their locations. An additional contribution of the present study is in the reported importance that the organizations attach to selections of an ERP system made by others in the industry which have applied MCDM methods. It is an important layer in understanding the selection process and the managerial behaviour involved in it. In conclusion, managers prefer to compare the

possible results of their objective decision making process according to the use of a decision making methodology to others in the industry before taking their own final selection decision.

5.6 Implications for management

The current study's results can be applied in the practice of management science. The current section will present some of the suggested aspects. As described in previous parts of the current research, there is no accepted method of decision making regarding the selection process of an ERP system. MCDM methods are one of the commonly used instruments during the ERP system selection process. A substantial gap recognized in the literature review is the absence of a closed list of criteria or agreed rankings of the criteria. A significant outcome of the current study is the top level criteria generated from the literature accompanied by the ratings of the criteria retrieved from the survey. These ratings, given by a relatively large sample of respondents, can be applied in practice as weightings in different MCDM methods. These weightings can be defined by the average ratings regardless of organizational characteristics in order to simplify the process. Another approach is to modify the weightings according to the organizational characteristics that were found to be significant in the results analysis of the present study.

In order to demonstrate the application concept, a subjective weighting method is used. Subjective methods are based on the decision maker's ratings of criteria and are determined by his own judgment of their importance. Naturally, the ratings of criteria used as weightings in this method are related to the decision maker's knowledge and experience (Ahn, 2011). A Weighting Sum Model (WSM) MCDM method was selected for the current demonstration due to its simplicity and descriptiveness. WSM is one of the most commonly used MCDM methods for a single dimensional problem. The conceptual definition of a WSM method is for '*m*' alternatives and '*n*' criteria. The preferred alternative, if this is a maximization case, is the one with maximal result (Triantaphyllou, 2000).

Application of the current research results to the WSM method is demonstrated below in Table 45. The weightings were divided by the total sum in order to receive a relative part of the weightings summary for each criterion.

Table 45. WSM method selection criteria of an ERP system application - example with average weight.

Criteria	Weight of the criteria	ERP system A score	ERP system B score	ERP system C score
Cost	0.14	10	8	4
Technology	0.15	8	6	10
Functionality	0.16	6	8	6
TIME	0.13	3	7	7
Market	0.15	4	8	9
Quality	0.15	8	5	8
Multilingual system	0.12	3	5	5
Total Score		**6.1**	**6.8**	**7.0**

Source: own elaboration

The WSM score of ERP system A alternative, example of calculation steps:

$$Score\ of\ ERP\ system\ A\ alternative = 10\times0.14 + 8\times0.15 + 6\times0.16 + 3\times0.13$$

$$+ 4\times0.15 + 8\times0.15 + 3\times0.12 = 6.1$$

The calculation steps are similar to the above example for all three alternatives.

Therefore, in the current example, the preferred alternative with the highest score is ERP system C.

The approach of modified weightings, according to the organizational characteristics, can also be applied and demonstrated in the same manner (Table 46 and Table 47).

Table 46. WSM method selection criteria for an ERP system application - example with weightings of a Medium size organization.

Criteria	Weight of the criteria Medium size org.	ERP system A score	ERP system B score	ERP system C score
Cost	0.14	10	8	4
Technology	0.15	8	6	10
Functionality	0.16	6	8	6
Time	0.13	3	7	7
Market	0.15	4	8	9
Quality	0.15	8	5	8
Multilingual system	0.12	3	7	5
Summary		**6.1**	**7.0**	**7.1**

Source: own elaboration

Table 47. WSM method selection criteria for an ERP system application - example with weightings of a Small size organization.

Criteria	Weight of the criteria Small size org.	ERP system A score	ERP system B score	ERP system C score
Cost	0.15	10	8	4
Technology	0.15	8	6	10
Functionality	0.16	6	8	6
Time	0.14	3	7	7
Market	0.15	4	8	9
Quality	0.15	8	5	8
Multilingual system	0.11	3	8	5
Summary		**6.2**	**7.1**	**7.1**

Source: own elaboration

In this scenario, for a Medium size organization the preferred alternative will be ERP system C but for the Small size organization the alternatives of ERP system B and ERP system C will be identical and therefore interchangeable. These differences reflect the variance in the weightings given by the decision makers. The described pattern can be applied to different organizational characteristics that were identified as significant during the results analysis e.g. the location of the organization.

Another contribution to managerial practice in this field is the point of view suggested on external consultancy services during the selection process. The conclusions of the present study can encourage managers to use external consultancy services through an ERP system selection process due to their positive contribution to successful selection as reported in the conducted survey.

An additional aspect that can be taken into account when the selection process is being carried out is the tendency to follow other organizations' selections or at least consider their decisions as important. The current research draws the conclusion that it can be considered popular to rely on successful selection within the industry. However, in the present study, there is no indication of the importance of industry type to the selection being made and the same rankings of criteria can be applied to all industries.

5.7 Recommendations for future research

This section is mainly based on the discussion and limitation parts of the current chapter.

Further research is needed to test whether there are differences in the use of methodologies according to different sizes and types of organization. This could contribute to the understanding of organizational behaviour and the decision making process according to organizational characteristic parameters.

The current research raises uncertainty regarding the actual contribution of using MCDM methods to successful selection processes compared to the contribution of other instruments (i.e. rule of thumb or consultant recommendations). The reviewed literature dealt mainly with the comparison of one MCDM method with another or description of the process of selection with the use of MCDM. No evidence of the contribution of examining MCDM methods to a successful selection or implementation project was recorded. Taking into account the large

number of studies that focus on the application of MCDM methods, it is highly recommended, according to the results of the current study, to perform dedicated research to confirm or reject these findings.

One of the limitations of the current research that should be addressed in future research is the collection of more complete information regarding the previous experience of the survey participants.

Another subject for further investigation is the dynamic criteria which allow the second level criteria not to be linked constantly to a specific top level criterion. Their location under a top level criterion can change dynamically based on a decision maker's decision or organizational characteristics (Yu & Chen, 2012; Zardari et.al., 2015). This method's possible advantage can be flexibility and, as a result, it can be more specifically tailored to the selection process.

Moreover, future research should cover the tendencies of cloud structured ERP systems to replace traditional on-premises ERP systems, which was left out of the current study's scope though the data was collected and should be used for future studies in this field.

5.8 Conclusion

The current research aimed to identify the link between different elements of the decision making process for ERP system selection and its successful result. It was based on a literature review that enabled recognition of the existing gap in the knowledge. In order to reduce the gap, the research problem was formulated; research objectives, questions and hypotheses were defined. The research problem was stated as the absence of a predefined pattern for the ERP system selection process, considering the importance of different factors in the decision making process in general and criteria ratings specifically, including: consultants, industry specificity, application of decision making methodologies, organizational size, roles of the decision makers in the organization and demographic uniqueness.

With the intention of solving the research problem, the research methodology was designed and a unique global survey was conducted. The results of the survey were analysed using different statistical instruments, validated according to the hypotheses and discussed. The results revealed some important patterns in management and organizational behaviour

and emphasized differences between elements of the decision making process, such as dependency between criteria ratings and organizational location, the high appreciation given to external consultants, the uncertainty of the benefits of using MCDM methods and more. Summarizing the research, it may be stated that the research problem was mainly solved by revealing a pattern, using the results reported by the survey participants, taking into account the differences and the similarities demonstrated between the various elements of the process. Research questions were answered and hypotheses partially supported. The implications for academic research, the reduction in the knowledge gap and the contribution to practical management were described. The latter included suggestions for practical application of the research results using WSM or another type of MCDM method. Recommendations and suggestions for future research were made.

The most valuable outcome of the current study from a scientific point of view is the demonstration of different levels of importance of organizational characteristics, environment and external consultants to the ERP system selection process's success while casting doubt on the benefits and necessity of using and researching decision making methodologies in this process.

From a practical point of view, the most important outcome of the study is the contribution to managerial awareness of the differences in importance of elements in the process of ERP system selection and the ability to apply, based on this understanding, the ratings from this and future studies.

Based on the research results, it can be concluded that there are managerial behavioural patterns during the decision making process that are valuable, together with different organizational characteristics, to the successful selection process and that it is possible to make use of these patterns in order to reduce the possibility of failure in the selection of an ERP system.

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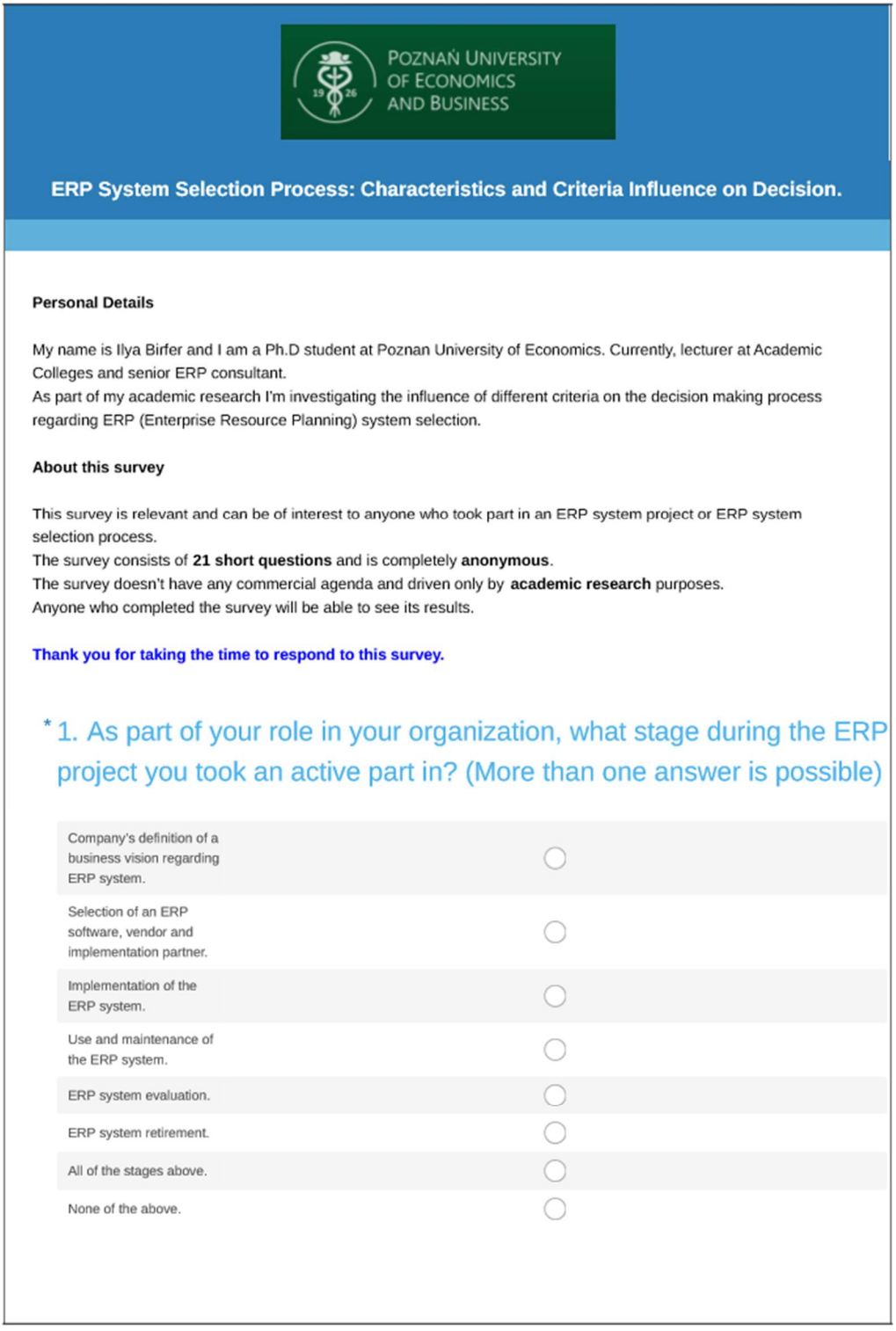
Appendix A - Questionnaire

The current questionnaire (Appendix A) chapter 3



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ERP System Selection Process: Characteristics and Criteria Influence on Decision.

Personal Details

My name is Ilya Birfer and I am a Ph.D student at Poznan University of Economics. Currently, lecturer at Academic Colleges and senior ERP consultant.
As part of my academic research I'm investigating the influence of different criteria on the decision making process regarding ERP (Enterprise Resource Planning) system selection.

About this survey

This survey is relevant and can be of interest to anyone who took part in an ERP system project or ERP system selection process.
The survey consists of **21 short questions** and is completely **anonymous**.
The survey doesn't have any commercial agenda and driven only by **academic research** purposes.
Anyone who completed the survey will be able to see its results.

Thank you for taking the time to respond to this survey.

* 1. As part of your role in your organization, what stage during the ERP project you took an active part in? (More than one answer is possible)

- Company's definition of a business vision regarding ERP system.
- Selection of an ERP software, vendor and implementation partner.
- Implementation of the ERP system.
- Use and maintenance of the ERP system.
- ERP system evaluation.
- ERP system retirement.
- All of the stages above.
- None of the above.

* 2. Were there several alternatives suggested during the selection stage?

- ◯ No alternative ERP systems were suggested.
- ◯ The selection was between 3 or more different ERP systems.
- ◯ The selection was between 2 different ERP systems.
- ◯ Not relevant.

* 3. Was a Cloud based ERP system one of the alternatives considered?

- ◯ Yes, one or more of the alternatives were a cloud based ERP system.
- ◯ I don't know.
- ◯ Not relevant.
- ◯ No, all the alternative were on-premises ERP systems.

* 4. In your opinion, was the selection process of the ERP system professionally done?

- ◯ Yes.
- ◯ It is hard to tell.
- ◯ No.
- ◯ I don't know.
- ◯ Partially.
- ◯ Not relevant.

* 5. If an external consultant services were used during the selection process, in your opinion, was the recommendation submitted by him impartial?

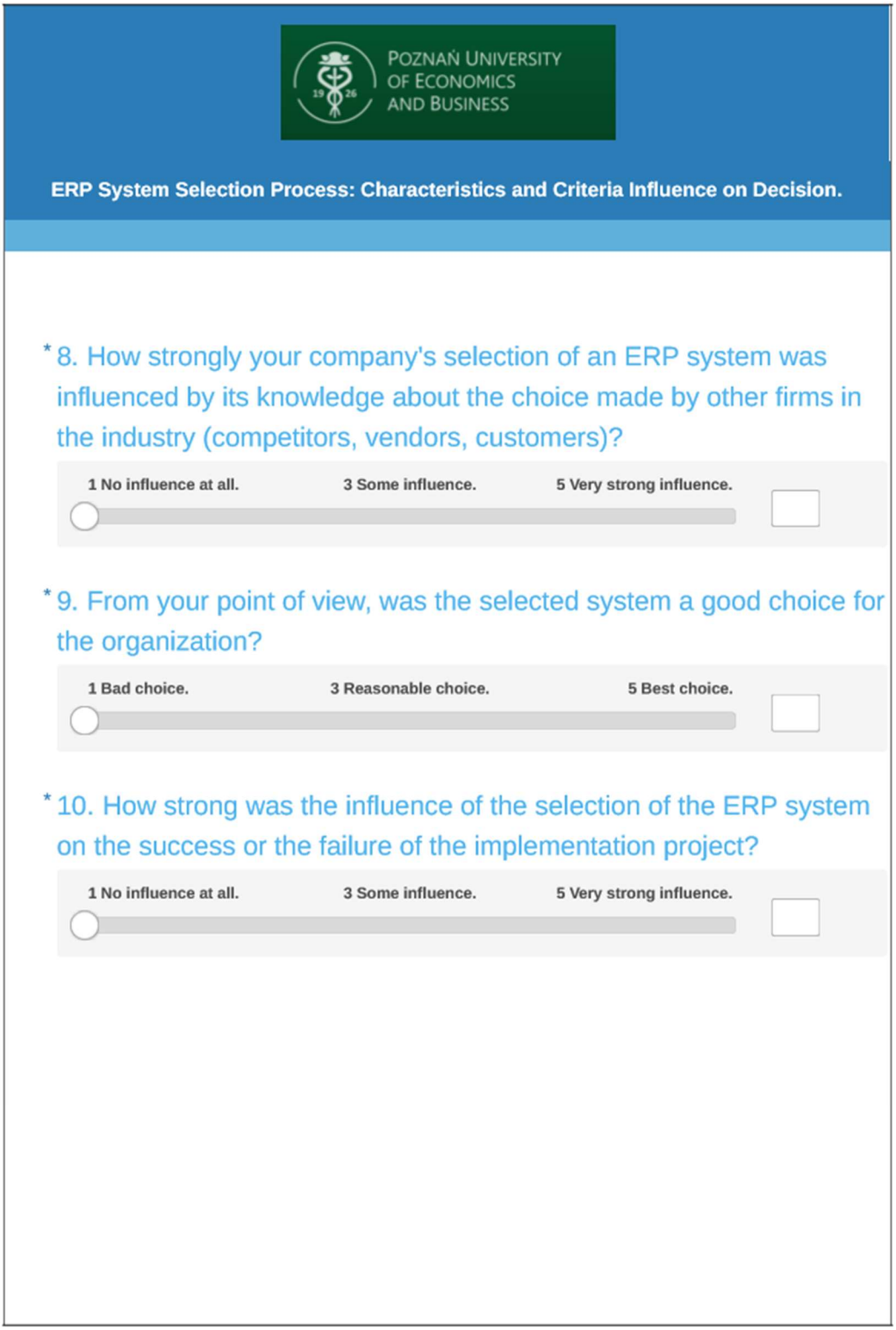
- ◯ Yes, the recommendation was impartial.
- ◯ I don't know.
- ◯ No, the results were bias.
- ◯ No external consultant was used during the selection process.
- ◯ It is hard to tell.
- ◯ Not relevant.

* 6. If an external consultant services were used during the selection process, did the company accept the recommendation of the consultant?

- ◯ Yes, the recommendations were fully accepted.
- ◯ The company asked for a second opinion before deciding.
- ◯ No, the recommendations were fully rejected.
- ◯ I don't know.
- ◯ The recommendations were partially accepted.
- ◯ Not relevant.

* 7. Was there a use of a Decision Making Methodology during the ERP selection process?

- ◯ Yes, there was a use of a decision making methodology for the selection.
- ◯ No, there was no use of a decision making methodology for the selection.
- ◯ I don't know.
- ◯ Not relevant.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ERP System Selection Process: Characteristics and Criteria Influence on Decision.
* 8. How strongly your company's selection of an ERP system was influenced by its knowledge about the choice made by other firms in the industry (competitors, vendors, customers)?
1 No influence at all.
3 Some influence.
5 Very strong influence.
* 9. From your point of view, was the selected system a good choice for the organization?
1 Bad choice.
3 Reasonable choice.
5 Best choice.
* 10. How strong was the influence of the selection of the ERP system on the success or the failure of the implementation project?
1 No influence at all.
3 Some influence.
5 Very strong influence.

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* 11. On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.

	1 No influence at all.	2 Minor influence.	3 Some influence.	4 Strong influence.	5 Very strong influence.
Total cost	◯	◯	◯	◯	◯
ROI (Return of Investment)	◯	◯	◯	◯	◯
Relevance of technology	◯	◯	◯	◯	◯
Compatibility with third party	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯

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* 12. On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.

	1 No influence at all.	2 Minor influence.	3 Some influence.	4 Strong influence.	5 Very strong influence.
Security	◯	◯	◯	◯	◯
Configuration Approach	◯	◯	◯	◯	◯
Simplicity of technology	◯	◯	◯	◯	◯
Service and support	◯	◯	◯	◯	◯
Technical requirements and performances	◯	◯	◯	◯	◯

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* 13. On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.

	1 No influence at all.	2 Minor influence.	3 Some influence.	4 Strong influence.	5 Very strong influence.
Functional capability	◯	◯	◯	◯	◯
Multilingual system	◯	◯	◯	◯	◯
Functional Fit and Flexibility	◯	◯	◯	◯	◯
Time of full implementation	◯	◯	◯	◯	◯
Training time	◯	◯	◯	◯	◯

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* 14. On a scale of 1-5 with 5 being the strongest influence, please rate the following criteria as to their importance to an ERP System selection decision.

	1 No influence at all.	2 Minor influence.	3 Some influence.	4 Strong influence.	5 Very strong influence.
System General Reputation	◯	◯	◯	◯	◯
Systems vendor future vision and strategy	◯	◯	◯	◯	◯
System reputation industry specific	◯	◯	◯	◯	◯
Quality of implementation	◯	◯	◯	◯	◯
Quality of training and support	◯	◯	◯	◯	◯

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ERP System Selection Process: Characteristics and Criteria Influence on Decision.

The following statements are for demographic classification only.

* 15. What is the company decision making unit regarding ERP selection / headquarters location?

* 16. What was the location of your position during the ERP system selection process?

* 17. What was your position during the ERP selection and implementation project?

- ◯ Business analyst/Functional consultant
- ◯ Project Manager
- ◯ CIO
- ◯ CFO
- ◯ Other (please specify)
- ◯ CEO
- ◯ CTO
- ◯ ERP Team Manager
- ◯ External ERP Selection Consultant

* 18. What is the size of the company you took part in an ERP Project for?

- ◯ 1-200 employees
- ◯ 201-1,000 employees
- ◯ 1,001-10,000 employees
- ◯ 10,001-50,000 employees
- ◯ 50,001+employees

* 19. What is the type of the company you took part in an ERP Project for?

- ◯ For-Profit Corporation
- ◯ Non-Profit Organization
- ◯ Other (please specify)
- ◯ Government Organization

* 20. Which of the following best describes the principal industry of the organization you relate to in your answers?

* 21. What is your age?

- ◯ 18 to 29
- ◯ 30 to 49
- ◯ 50 to 64
- ◯ 65 years and over

Appendix B - Second level criteria list with references

Table 1. Second level Criteria list classified by top level criteria.

Criteria Number	Cost	Criteria Number	Technology	Criteria Number	Functionality	Criteria Number	TIME	Criteria Number	MARKET	Criteria Number	QUALITY
11	Service cost	1	Relevant technology	2	Innovative business process	16	Training	3	Competitive position	90	Quality
12	Operating cost	6	Compatibility with third party	5	Functional capability	37	Implementation speed	4	Consumer preference	117	Domain knowledge
13	Set-up cost	7	Reliability	19	Multi-level user	49	Implementation time	40	Market share	170	Service and support quality
35	Cost drivers	8	Security	21	National CRM	53	implemintation	47	Strategic fitness	176	Quality and availability of support
41	Financial capability	10	Configuration	29	Synchorizing modules to workflow	56	implementation time	62	Vendor's reputation	189	Training quality
50	Total costs	14	Performance	34	Business drivers	65	Implementation Ease of Customization	67	Implementation Vendor Reputation	191	System support quality
58	Return on Investment	15	Usability	39	International orientation	66	Software Ease of Use	73	References	9	Information Quality
59	Total cost of ownership	17	Data share	45	System Factors	69	Implementation Ease	74	Vision	32	User support
63	Software Cost	18	Compatibility with the system	46	Functionality	110	Implementation time	78	Vendor market position	44	Service support
76	Consultancy	20	Flexibility	60	Functional fit of the system	113	Training time	115	Vision		
83	Cost	22	Web applications	61	Flexibility	129	Implementation time	116	Market position		
88	Total cost	23	Complexity of technology East of database administration	64	Software Functionality	134	Implementation period	118	Reputation		
91	Price	24	Ease of business logic implementation	71	Cross module integration	136	Degree of training required	160	Organizational credibility		
104	Initial cost	25	Ease of presentation layer implementation	81	Fit with organization	154	Training to relevant employees	169	Vendor's reputation		
105	Training cost	26	Ease of administration	87	Integration	159	Support	178	Vendor reputation		
106	IMonthly cost	27	Ease of service exposure Resource utilization	96	Usability	161	Experience	179	ERP reliability		
107	Customization cost	28	Database migration	97	Functionality	163	Customer focus				
108	Upgrading cost	30	User friendly interfaces	98	Multilingual	164	Future strategy.				
109	BPR cost	31	Integration with 3rd party software	101	Fit with organizational procedures	167	User friendliness				
127	Cost	33	Technical requirements	102	Quality documentation support	173	Easy of use				
130	Profit margins	36	Flexibility Scalability Business specific	121	Better fit with organizational structure	187	Ease and speed of implementation				
139	Financial risk	38	Link with other systems	124	Functionality	190	End-user readiness				
146	Infrastructure cost	42	Implementation ability	131	Supply chain management	192	implementation time				
147	Purchasing cost including all licenses	43	R&D capability	137	Modifications required for the existing processes						
148	Cost for training	48	User friendliness	138	Achieving the promised output						
149	Cost for version upgrades	51	Interface with other systems	142	Functional Fit and Flexibility						
156	Cost	52	easy of use	143	Customisation required						
166	Total cost of ownership	54	Service and support quality	157	Functionality						
172	Total cost of ownership	55	User friendliness	165	Functional fit of the system						
177	Total costs of ERP implementation Project	57	Quality and availability of support	171	Functionality						
		68	Software Reliability	174	Ability to tailor functionality without programming						
		70	Fit with allied organizations	188	Organizational ft						

Criteria Number	Technology
72	Compatibility with other systems
75	System reliability
77	Technical aspects
79	Ease of customization
80	Software methodology
82	Service & support
84	Vendor domain knowledge
85	Customer service
86	Reliability, availability, scalability
89	Service level
92	Customization
93	Maintainability
94	Reliability
95	Security
99	Local support
100	Fit with organizational systems
103	External parties support
111	Ease of implementation
112	Ease of learning
114	Support and service
119	Methodology of software
120	Ease of customization
122	Fit with parent/allied organizational system
123	Cross module integration
125	System reliability
126	Technical aspects
128	Compatibility
132	Customer support
133	Change Management and Implementability
135	Multi site implementability
140	Obsolescence of technology
144	User friendliness
145	Possibility to change with future business needs
150	Hardware requirement
151	Limitations for further development
152	Supportive staff
153	Past track of records
155	On site maintenance
158	Implementation approach
162	Flexibility
168	Flexibility
175	Must be an integrated suite
180	Ease of integration with other systems
181	Technology advance
182	Scalability
183	Upgrade ability
184	Customization/ parameterization possibilities
185	Ease of use
186	Flexibility and modularity

Table 2. Criteria numbers with reference.

ID	Reference	Criteria Number
1	(Baki, & Çakar, 2005)	92,114,115,116,117,118,119,120,121,122,123, 124,125,126,127,128,129
2	(Chen, Liang, & Hsu, 2015)	62
3	(Hailu & Rahman, 2012)	58
4	(Hossain & Shakir, 2001)	53
5	(Hua & Song, 2010)	52
6	(Illa, Franch & Pastor, 2000)	61
7	(Jutras, 2007)	171,172,173,174,175,176
8	(Karsak & Özogul, 2009)	54, 60
9	(Keil & Tiwana, 2006)	63,64,65,66,67,68
10	(López & Ishizaka, 2017).	93,94,95,96,97,98,99,100,101,102,103,104,105 ,106,107,108,109,110,111,112,113
11	(Ma, Pearson, & Tadisina, 2005).	57
12	(Perera, & Costa, 2008)	130,131,132,133,134,135,136,137,138,139,140 ,141,142,143,144,145,146,147,148,149,150,15 1,152,153,154,155
13	(Ratkevičius, Ratkevičius & Skyrius, 2012)	177,178,179,180,181,182,183,184,185,186,187 ,188,189,190,191
14	(Moller & Chaudhry, 2012)	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19 ,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34, 35,36,37,38,39,40,41,42,43,44,45,46,47,48,49, 50,51,69,70,71,72,73,74,75,76,77,78,79,80,81, 82,83,84,85,86,87,88,89,90,91
15	(Teltumbde, 2000)	165,166,167,168,169,170
16	(Ünal & Güner, 2009)	156,157,158,159,160,161,162,163,164
17	(Wei, Chien & Wang, 2005)	55,56,59,192

Appendix C - Industry type grouping

Table 1. Grouping by general industry type.

ID	Type of industry as presented in the survey	Grouping by industry types
1	Advertising & Marketing	Professional Services
2	Agriculture	Other
3	Airlines & Aerospace (including Defence)	Professional Services
4	Automotive	Manufacturing
5	Business Support & Logistics	Professional Services
6	Computer and Electronics Manufacturing	Manufacturing
7	Construction, Machinery, and Homes	Construction
8	Education	Education
9	Entertainment & Leisure	Other
10	Finance & Financial Services	Finance, Insurance & Realty
11	Food & Beverages	Manufacturing
12	Government & Public Administration	Non-profit
13	Healthcare & Pharmaceuticals	Healthcare
14	Import/Export	Professional Services
15	Information Services & Data Processing	Information Technology
16	Insurance	Finance, Insurance & Realty
17	Legal Services	Professional Services
18	Military	Other
19	Non-profit	Non-profit
20	Retail & Consumer Durables	Retail & Distribution
21	Real Estate	Finance, Insurance & Realty
22	Scientific or Technical Services	Professional Services
23	Software	Information Technology
24	Telecommunications, Technology, Internet & Electronics	Telecommunications
25	Tourism	Professional Services
26	Transportation & Delivery	Professional Services
27	Utilities, Energy, and Extraction	Manufacturing
28	Other	Other
29	General consulting	Professional Services
30	General manufacturing	Manufacturing

Appendix D - Grouping of countries by geographical location

Table 1. Grouping of countries by geographical location.

ID	List of countries by location of the organization as obtained from the survey	Grouping by Continent	European Union members	Former USSR members
1	AD - Andorra	Europe		
2	AE - United Arab Emirates	Asia		
3	AI - Anguilla	North America		
4	AL - Albania	Europe		
5	AM - Armenia	Europe		Former USSR
6	AR - Argentina	South America		
7	AT - Austria	Europe	European Union	
8	AU - Australia	Oceania		
9	BE - Belgium	Europe	European Union	
10	BR - Brazil	South America		
11	CA - Canada	North America		
12	CH - Switzerland	Europe		
13	CL - Chile	South America		
14	CZ - Czech Republic	Europe	European Union	
15	DE - Germany	Europe	European Union	
16	DK - Denmark	Europe	European Union	
17	ES - Spain	Europe	European Union	
18	FR - France	Europe	European Union	
20	GB - United Kingdom	Europe	European Union	
21	GE - Georgia	Europe		Former USSR
22	GR - Greece	Europe	European Union	
23	HR - Croatia	Europe	European Union	
24	HU - Hungary	Europe	European Union	

25	IE - Ireland	Europe	European Union	
26	IL - Israel	Asia		
27	IN - India	Asia		
28	IR - Iran	Asia		
29	IT - Italy	Europe	European Union	
30	JP - Japan	Asia		
31	KW - Kuwait	Asia		
32	KZ - Kazakhstan	Asia		Former USSR
33	LT - Lithuania	Europe	European Union	Former USSR
34	MA - Morocco	Africa		
35	MU - Mauritius	Africa		
36	MX - Mexico	North America		
37	MY - Malaysia	Asia		
38	NL - Netherlands	Europe	European Union	
39	NO - Norway	Europe		
40	NZ - New Zealand	Oceania		
41	PK - Pakistan	Asia		
42	PL - Poland	Europe	European Union	
43	PT - Portugal	Europe	European Union	
44	PW - Palau	Oceania		
45	QA - Qatar	Asia		
46	RS - Serbia	Europe		
47	RU - Russia	Europe		Former USSR
48	SA - Saudi Arabia	Asia		
49	SE - Sweden	Europe	European Union	
50	SG - Singapore	Asia		
51	SZ - Swaziland	Africa		
52	TR - Turkey	Asia		
53	TW - Taiwan	Asia		
54	UA - Ukraine	Europe		Former USSR
55	US - United States	North America		
56	VN - Vietnam	Asia		
57	ZA - South Africa	Africa		